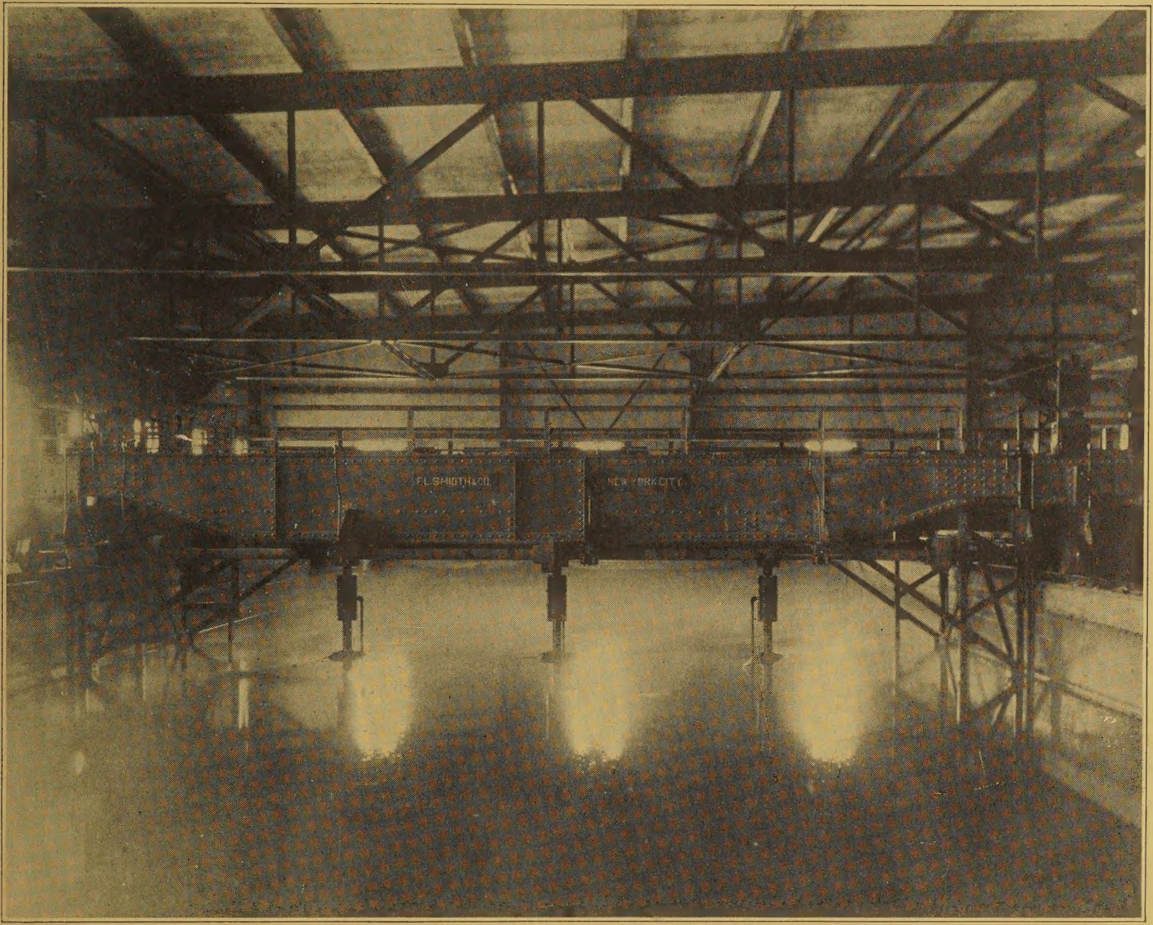
MILL SECTION of
Concrete

TRAVELING AGITATOR
(Patented)



SMIDTH Traveling Agitators with a total storage capacity of slurry sufficient for

173,185 barrels

of portland cement have been delivered to wet process plants in the United States and Canada.

The traveling platform carries the stirring arms and all operating machinery. The agitation is accomplished, not only by the stirring arms, but also by air which is injected into the mix through nozzles on the arms.

Low first cost, horsepower saving, reduction in upkeep and repairs are the advantages of the Traveling Agitator over the conventional stationary type.

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(Incorporated 1895)
ENGINEERS
DESIGNERS AND EQUIPPERS OF
CEMENT MAKING FACTORIES
225 Broadway NEW YORK, N. Y.
Factory, Foundry and Laboratory—Elizabeth, N. J.

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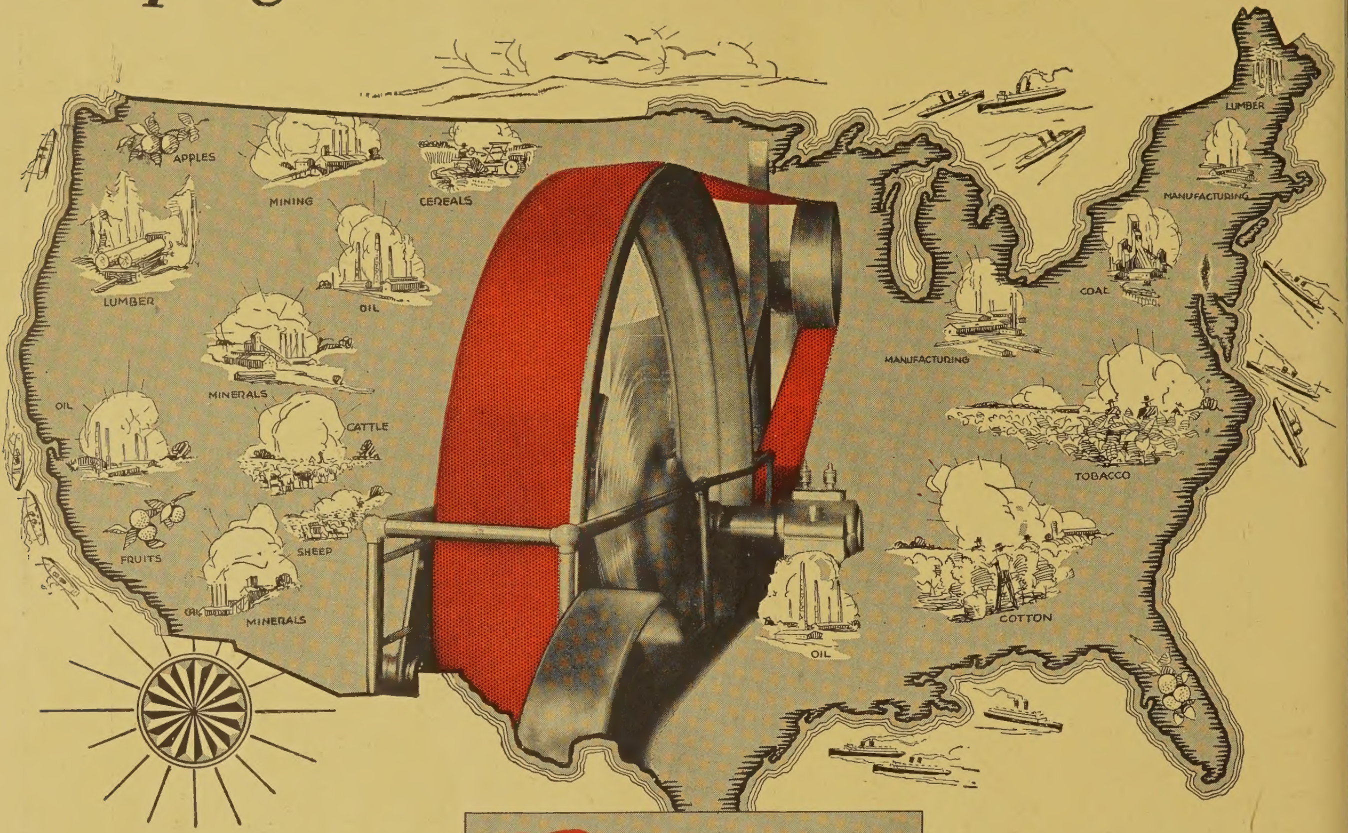
Another Claim to Fame— Helping to Enrich the National Wealth



Condor BELT

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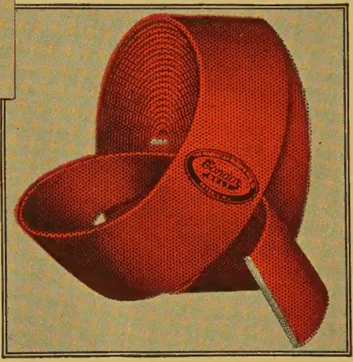
The picture above shows a 20″ 8 ply Condor Belt operating in the Planters Fertilizer Company in Charleston, S. C. This belt is 90 4/12 ft. long and operates a 16 x 36 Bates Corliss Steam Engine, developing 250 horsepower. The driving pulley is 12 ft. in diameter and develops 110 R.P.M. and the driven pulley is 68″ in diameter.

It is because of service records of this sort that users of Condor Belt are as faithful to Condor as it is to them.



All good belts are made to conform to rigid specifications but Condor carries this to an even greater point of perfection. Its component parts are built for aging. It is steeled against time.

Let us help you solve your belting problems. Our engineers may be able to cut down your belting costs and increase your power efficiency. You will be obligated in no way whatsoever.

THE MANHATTAN RUBBER MANUFACTURING CO.

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MILL SECTION of
Concrete

The Cement Mill Edition of Concrete is edited exclusively for those interested in the manufacture of cement. Its pages are devoted to discussions of plant design, management, operation, production efficiency, chemical research and control, quarry operation, progress and news of the industry.

The Cement Mill Edition also contains all the material published in the corresponding Regular Edition and so provides news of the uses and merchandising of the materials whose manufacture is discussed in the Mill Edition. The Regular Section furnishes mill operating officials and mill executives valuable points of contact with the users of the materials they produce.

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Bethlehem, Pa.

MILL SECTION of
Concrete

Vol. 35 Chicago, July, 1929 No. 1

The Cause of Unsoundness of Portland Cement

A Report of the Factors Causing Abnormal Expansion, Cracking or Distortion, Which Sometimes Occur When Portland Cements Are Subjected to Accelerated Tests for Unsoundness

By WM. LERCH[1]
Portland Cement Association Fellowship, Bureau of Standards, Washington, D. C.

THE various standard specifications for portland cement in use in different countries[2] almost all contain some form of accelerated test for soundness. The test most generally used is either the boiling test, the steam test, or the hot water test. In the United States[3] the steam test is used. This involves heating a pat prepared from neat cement paste for 5 hours in an atmosphere of steam at a temperature between 98 and 100 deg. C., the specimens to be 24 hours old when placed in the steam.

This report involves an investigation of the factors causing the abnormal expansion, cracking, or distortion collectively called unsoundness, which sometimes occur when portland cements are subjected to that test.

Review of the Literature

Le Chatelier[4] appears to have been the first to attribute expansion of cements in accelerated tests to any specific compound contained in the cement. He believed the expansion due to the hydration of free lime and magnesia to be the chief cause of unsoundness. This theory has had many followers, but there have also been a number of experimenters who opposed the theory either in whole or in part.

W. D. Taylor[5] believed that the most important factor operating in a cement to cause unsoundness is an excess of free or loosely combined lime, but that an excess of alkalies may also be responsible.

The rate of hydration of the free lime and free magnesia in cement was studied by Campbell and White.[6] They found that the free lime in cement is not completely hydrated, even when the specimens are immersed in water, until about 14 days. The gradual hydration of lime causes an abnormal expansion. The hydration of magnesia proceeds more slowly. Free lime can be detected by the boiling test, but free magnesia cannot. With the development of White's[7] test for the qualitative identification of free lime a number of commercial cements were tested by Campbell and White for free lime and soundness. In most of these cements free lime was absent, but when free lime was present it was generally associated with unsoundness.

Riebling and Reyes[8] examined a number of cements by White's method and found the agreement between the microscopic evidence of free lime and the results of tests for unsoundness to be very close.

B. F. Erdahl[9] is opposed to the free lime theory as the explanation of unsoundness. After a rather extensive study of the causes of unsoundness, Erdahl concludes that underburning with the formation of dicalcium silicate is the real cause of unsoundness in cement.

In reply to this paper Rankin[10] upholds the free lime theory in opposition to the explanation advanced by Erdahl. Rankin states that microscopic examination of finely ground cement has shown that a grain of cement, even so small that it will pass a 200 sieve, may consist of a perfectly sound shell, free from cracks, but enclosing one or more particles of free lime. He furthermore holds that such enclosed particles of free lime may be evenly distributed throughout the cement and will ultimately cause unsoundness, provided the water does not penetrate the shell and hydrate the lime before the cement sets.

Bates[11] expresses the opinion that free lime produces the expansive force to cause unsoundness, but that the amount of free lime necessary to produce unsoundness will vary. A slow hardening cement will expand from the influence of a smaller quantity of free lime than a quick hardening cement because it will have less adhesive force to counteract the expansive force produced by the hydration of this lime.

Without offering any substitution for the free lime theory, Meade[12] expresses doubt concerning both the free lime and the dicalcium silicate theories.

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[1] Publication approved by the Director of the National Bureau of Standards of the U. S. Department of Commerce. Paper No. 20 of the Portland Cement Association Fellowship at the Bureau of Standards.

[2] C. R. Platzmann, *Rock Products*, 31, No. 2 (1928), 97.

[3] U. S. Government Master Specifications for Portland Cement. Bu. Std. Circular 33, 4th ed.

[4] *Bull. Soc. d'enc. l'ind. nat.*, November (1898).

[5] *A. S. T. M.*, 3 (1903), 374.

[6] *J. Am. Chem. Soc.*, 28 (1906), 1273.

[7] *J. Ind. Eng. Chem.*, 1 (1909), 5.

[8] *Philippine J. Sci.*, 5A (1910), 367.

[9] CONCRETE, C. M. S., 14 (1919), 27; 15 (1919), 56; 16 (1920), 43.

[10] CONCRETE, C. M. S., 15 (1919), 33.

[11] CONCRETE, C. M. S., 15 (1919), 36.

O. R. Smith[13] believes that free lime is the cause of unsoundness in portland cement and J. C. Witt[14] states that he has used the free lime theory as a working basis in plant practice with satisfactory results.

Kühl[15] does not think that the present volume constancy test is adequate. He considers hydration to be too complicated a problem to be tested by a rapid boiling test. His idea is that during the setting of cement colloidal and crystalline products are formed. An excess of the colloids causes the cements to have a low strength while an excess of the crystalloids causes the cement to crack. The boiling test is too rapid to allow colloids to form, but it greatly increases crystal formation and thereby causes cracking. Kühl does not believe that free lime can be the cause of unsoundness, since the addition of free lime to a sound cement does not produce unsoundness and also because, in the hydration of cement, a large amount of lime is split off by hydrolysis. This lime crystallizes as $Ca(OH)_2$ and does not cause disintegration of the pat.

Dwyer[16] found that the age of the test specimen is an important factor in determining the extent of expansion and cracking in the steam test. Some portland cements were found to be sound, when subjected to the steam test 24 hours after the preparation of the pat, while similar pats made from the same cement were found to be unsound when cured for a longer period before testing. He also found that a number of cements which were unsound in the standard one day test could be cured by exposure to the atmosphere so as to pass a satisfactory steam test for one day pats, while other pats tested at 3 to 5 days were unsound.

Present Investigation

Rankin[17] and Bates[18] state that the major compounds present in a well burned portland cement clinker are: $3CaO.SiO_2$, $2CaO.SiO_2$, $3CaO.Al_2O_3$, $5CaO.3Al_2O_3$, $2CaO.Fe_2O_3$, with, possibly a small amount of free lime.

Papers issued from this laboratary have indicated that ferric oxide is combined, in mixtures similar to portland cement, as $4CaO.Al_2O_3.Fe_2O_3$,[19] and that magnesia is present as free MgO.[20] [21]

The present study of the cause or causes of unsoundness is a part of the general investigation on the setting and hardening of portland cements which is being carried on in this laboratory. There have been examined by the steam test for unsoundness the pure compounds, listed above, mixtures of the compounds, laboratory cements prepared from pure materials and containing definite quantities of these compounds, and a number of commercial portland cements.

In each case a quantitative determination for free lime was made by the ammonium acetate titration method.[22]

The results included in this report involve only the causes for unsoundness as determined by the steam test and do not include any information which would indicate the relative merits of sound and unsound cements when used in concrete or mortar.

Pure compounds, mixtures and laboratory cements.—The pure compounds and laboratory cements used in this investigation were prepared in an up-draft gas fired kiln in the manner described in a previous paper.[23] In each case the temperature and time of heating were such that complete combination was effected as determined by the quantitative test for free lime.

The analyses of the raw materials used in the preparation of these materials are given in Table I.

Table I.—Partial Compositions of Raw Materials

	Calcium Carbonate	Alumina	Ferric Oxide	Silica	Magnesia
SiO_2	nil	0.01	0.02	98.75	0.08
Al_2O_3	0.08	98.48	—	0.61	0.02
Fe_2O_3	0.01	0.002	99.02	0.31	0.01
CaO	55.73	nil	0.20	0.30	0.50
MgO	0.01	—	—	—	84.22
Alkalies	0.04	—	—	—	—
SO_3	trace	—	trace	—	—
Cl.	trace	—	—	—	—
CO_2	44.10	—	—	—	—
Ignition loss	—	1.42	0.59	0.12	15.31

A chemically pure gypsum, $CaSO_4.2H_2O$ was added to the clinker in such quantity as to give 2.0 per cent SO_3 in the resulting product. The cements were then ground in a ball mill to such fineness that approximately 10 per cent was retained on a 200 sieve.

Free lime was determined immediately after grinding. Normal consistency was not determined, but pats were prepared by adding water to give a consistency as near to normal as could be determined by the working of the pats. Time of set and soundness of the materials were determined within 1 week after grinding.

Table II gives the results of the soundness tests on the pure compounds and Table III the same on some mixtures of those compounds.

Table IV gives the results of the soundness tests on a series of laboratory cements. These cements were prepared by burning in the up-draft gas fired kiln at 1450 deg. C. ± 20 deg. for 2 hours. This table includes also the ultimate composition of these cements. The compound composition is calculated on the assumption that the alumina and ferric oxide compounds, which form at low temperatures, would be formed first and take up their requisite amount of lime. The remaining lime would go to form $2CaO.SiO_2$ and $3CaO.SiO_2$; the magnesia would be present as free magnesia. Since there was no dusting in any of the cements the $2CaO.SiO_2$ would be present as $\beta 2CaO.SiO_2$.

Commercial cements.—Table V gives the results of the soundness tests on a number of commercial cements. In this case the clinkers were ground with gypsum at the time they were received at the laboratory and the soundness determinations made within one week after grinding. The ultimate composition and the compound composition of the clinkers are given. The compound composition is calculated in the same manner as that of the laboratory cements. The alkalies are not included, however, since the compounds which the alkalies may form are not known. By difference from a total of the other components present, the alkalies are found to be present in

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[12] CONCRETE, C. M. S., 15 (1919), 70.

[13] CONCRETE, C. M. S., 16 (1920), 46.

[14] CONCRETE, C. M. S., 14 (1920), 15.

[15] *Zement*, 14 (1925), 457.

[16] CONCRETE, C. M. S., 17 (1920), 87.

[17] *J. Ind. Eng. Chem.*, 3 (1911), 211.

[18] CONCRETE, CEMENT AGE C. M. S., 2 (1913), 3.

[19] Hansen. Brownmiller and Bogue, *J. Am. Chem. Soc.*, 50 (1928), 396.

[20] W. C. Hansen, *J. Am. Chem. Soc.*, 50 (1928), 3081.

[21] In a former publication (Hansen and Brownmiller, *Am. J. Sci.*, 15 [1928], 225) it was reported that MgO enters into solid solution with $4CaO . Al_2O_3 . Fe_2O_3$, the end member of the series being $4CaO . 2MgO . Al_2O_3 . Fe_2O_3$. Magnesia in excess of that required for the above combination was found to remain as uncombined MgO. More recent information obtained in this laboratory indicates that the amount of the solid solution is much smaller than had previously been reported. Although there is no reasonable doubt that a large part of the magnesia remains uncombined, the exact nature and degree of the reaction by which the $4CaO . Al_2O_3 . Fe_2O_3$ is changed in color and pleochroism in the presence of a small amount of magnesia has not been determined. This problem is under further investigation. At present the magnesia may be considered as remaining essentially uncombined, and the iron compound as existing essentially in the form $4CaO . Al_2O_3 . Fe_2O_3$.

[22] Wm. Lerch and R. H. Bogue, *Ind. Eng Chem.*, 18 (1926), 739.

[23] Lerch and Bogue, *J. Phys. Chem.*, 31 (1927), 1627.

Table II.—Results of Steam Test for Soundness of Pure Compounds

Compound	Per Cent Free Lime	Per Cent Water Used	Time of Set (Gilmore) Initial Hours	Initial Minutes	Final Hours	Final Minutes	Soundness Steam Test
$3CaO.SiO_2$	0.4	30	4	10	6	0	O.K.
$\beta 2CaO.SiO_2$	0.0	22	4	30	24*	—	O.K.†
$\gamma 2CaO.SiO_2$	0.0	40	Does not set and had such poor hydraulic properties that pat disintegrated in steam test.				
$5CaO.3Al_2O_3$	0.0	45	0	5	0	15	O.K.
$3CaO.Al_2O_3$‡	0.0	54	1	10	2	0	O.K.
$4CaO.Al_2O_3.Fe_2O_3$	0.0	43	0	5	0	20	O.K.
$2CaO.Fe_2O_3$	0.0	20	0	30	6	0	O.K.

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*More than 24 hours.

†Not very hard after steaming but firm on the plate with no evidence of expansion.

‡Not a true time of set since the paste steams vigorously and has a flash set when mixed with water. Was then regauged with more water.

Table III.—Results of Steam Test for Soundness of Mixtures of Pure Compounds

Mixture of Compounds	Per Cent	Per Cent Free Lime	Per Cent Water Used	Time of Set (Gilmore) Initial Hours	Initial Minutes	Final Hours	Final Minutes	Soundness Steam Test
$3CaO.SiO_2$	50	0.2	25	3	45	6	20	O.K.
$\beta 2CaO.SiO_2$	50							
$3CaO.SiO_2$	50	0.2	38	5	15	9	15	O.K.
$\gamma 2CaO.SiO_2$	50							
$3CaO.SiO_2$	42.5	0.2	26	0	10	1	15	O.K.
$\beta 2CaO.SiO_2$	42.5							
$5CaO.3Al_2O_3$	15.0							
$3CaO.SiO_2$	42.5	0.2	29	3	0	5	15	O.K.
$\beta 2CaO.SiO_2$	42.5							
$3CaO.Al_2O_3$	15.0							
$3CaO.SiO_2$	42.5	0.2	26	3	15	5	45	O.K.
$\beta 2CaO.SiO_2$	42.5							
$4CaO.Al_2O_3.Fe_2O_3$	15.0							
$3CaO.SiO_2$	42.5	0.2	27	5	30	8	0	O.K.
$\beta 2CaO.SiO_2$	42.5							
$2CaO.Fe_2O_3$	15.0							

Table IV.—Results of Steam Test for Soundness of Laboratory Cements

Number	Ultimate Composition CaO	Al_2O_3	Fe_2O_3	MgO	SiO_2	Compound Composition Free MgO	$4CaO.Al_2O_3.Fe_2O_3$	$2CaO.Fe_2O_3$	$3CaO.Al_2O_3$	Free CaO	$3CaO.SiO_2$	$2CaO.SiO_2$	Per Cent Water Used	Time of Set (Gilmore) Initial Hrs.	Initial Min.	Final Hrs.	Final Min.	Soundness Steam Test
1	68.7	10.0	0.0	0	21.3	0	0	0	27	0.2	50	24	25	3	0	4	30	O.K.
2	65.5	7.5	2.5	0	24.5	0	8	0	16	0.0	25	52	25	4	25	6	45	O.K.
3	67.5	7.5	2.5	0	22.5	0	8	0	16	0.0	50	27	25	3	35	6	0	O.K.
4	69.2	7.5	2.5	0	20.8	0	8	0	16	0.5	68	9	26	2	40	5	45	O.K.
5	65.5	7.5	2.5	2.0	22.5	2	8	0	16	0.0	42	32	26	4	20	6	30	O.K.
6	62.5	7.5	2.5	5.0	22.5	5	8	0	16	0.0	30	42	25	4	30	6	45	O.K.
7	59.5	7.5	2.5	8.0	22.5	8	8	0	16	0.0	18	51	25	3	30	6	0	O.K.
8	66.2	7.4	2.4	2.0	22.0	2	7	0	15	0.0	49	26	25	3	30	5	45	O.K.
9	64.1	7.2	2.4	5.0	21.4	5	7	0	15	0.0	47	26	24	3	45	5	15	O.K.
0	62.1	6.9	2.3	8.0	20.7	8	7	0	14	0.0	46	25	24	3	45	5	15	O.K.
1	68.0	6.0	2.0	0.0	24.0	0	6	0	13	0.0	50	31	25	3	15	5	15	O.K.
2	67.2	9.0	3.0	0.0	20.8	0	9	0	19	0.0	50	22	25	3	0	5	15	O.K.
3	64.3	5.0	5.0	0.0	25.7	0	15	0	5	0.0	25	55	24	4	0	6	0	O.K.
4	66.5	5.0	5.0	0.0	23.5	0	15	0	5	0.0	50	30	24	3	30	5	30	O.K.
5	68.1	5.0	5.0	0.0	21.9	0	15	0	5	0.0	70	10	25	2	45	5	0	O.K.
6	65.8	2.5	7.5	0.0	24.2	0	12	6	0	0.0	50	32	22	3	10	6	0	O.K.
7	65.4	0.0	10.0	0.0	24.6	0	0	17	0	0.0	50	33	22	3	20	6	45	O.K.
8*	64.0	7.5	2.5	0.0	23.0					0.0			26	1	30	3	0	O.K.

---

*Na_2O 1.5; K_2O 1.5.

Table V.—Results of Steam Test for Unsoundness of Commercial Portland Cement

	Utimate Composition of Clinker							Compound Composition of Clinker								Time of Set (Gilmore)				Soundness	
Number	CaO	Al_2O_3	Fe_2O_3	MgO	SiO_2	SO_3	Ig. Loss	Free MgO	$4CaO.Al_2O_3 Fe_2O_3$	$3CaO.Al_2O_3$	Free CaO	$CaSO_4$	$3CaO.SiO_2$	$2CaO.SiO_2$	Per Cent Water Used	Initial H.	Initial M.	Final H.	Final M.	24 Hrs.	120 Hrs.
1	65.2	4.9	0.5	1.3	25.0	0.1	2.4	1.3	1	13	5.5	0.2	19	57	23	3	10	7	45	Uns.	Uns.
2	63.0	6.3	4.4	3.4	21.9	0.3	0.1	3.4	13	9	0.0	0.5	40	32	22	3	55	6	0	O.K.	O.K.
3	64.1	6.3	2.4	2.8	23.0	0.2	0.4	2.8	7	13	0.4	0.3	37	38	23	3	50	6	0	O.K.	O.K.
4	65.0	7.4	2.8	2.1	22.9	0.6	0.4	2.1	9	15	0.4	1.0	41	32	23	2	50	4	30	O.K.	O.K.
5	66.0	4.8	4.6	0.8	21.9	....	1.4	0.8	14	5	0.6	....	60	17	23	4	0	6	40	O.K.	O.K.
6	64.5	7.5	2.9	4.2	20.4	0.3	0.4	4.2	9	15	0.6	0.6	50	21	23	2	45	4	20	O.K.	O.K.
7	64.7	5.9	4.0	1.8	22.4	0.6	0.1	1.8	12	9	0.7	0.9	43	32	23	3	0	5	0	O.K.	O.K.
8	61.7	9.4	3.5	4.5	17.8	1.9	1.8	4.5	10	19	0.8	3.2	39	22	23	3	10	5	0	O.K.	O.K.
9	65.0	4.1	4.2	3.8	22.3	0.1	0.3	3.8	13	4	2.0	0.2	53	24	25	4	40	7	30	Uns.	Uns.
10	64.8	6.1	3.6	3.1	20.4	0.1	1.1	3.1	11	11	1.8	0.2	53	19	26	5	20	8	0	O.K.	O.K.
11	61.7	5.2	1.8	2.7	20.2	1.8	6.6	2.7	5	11	7.8	3.0	23	41	24	3	0	4	50	Uns.	Uns.
12	62.7	5.3	1.8	2.8	20.7	1.8	4.8	2.8	5	11	6.9	3.0	26	40	24	3	30	6	50	Uns.	Uns.

very small amounts in each case. The ignition loss has been ignored but if a part of the ignition loss was due to CO_2 the $3CaO.SiO_2$ would be slightly lower and the $2CaO.SiO_2$ slightly higher than the values given in the table.

(To be continued)

Testing Society Announces Officers' Nominations

The nominating committee of the American Society for Testing Materials has made announcement of its nominations for officers, as follows: T. D. Lynch, consulting metallurgical engineer, Westinghouse Electric and Manufacturing Company, president, and F. O. Clements, technical director of the research laboratories of the General Motors Corporation, vice-president.

The nominations for the executive committee are as follows:

G. B. Haven, professor of Machine Design, in charge of Textile Laboratory, Massachusetts Institute of Technology, Cambridge, Mass.;

C. R. Hook, vice-president and general manager, American Rolling Mills Co., Middletown, Ohio;

H. E. Smith, engineer of materials, New York Central Lines, New York City;

G. E. Warren, assistant general manager, Portland Cement Association, Chicago, Illinois.

These nominations were made by the nominating committee, consisting of W. H. Fulweiler, J. H. Gibboney and H. F. Moore (serving ex officio); E. D. Boyer, J. J. Shuman, G. H. Clamer, Prevost Hubbard, M. E. McConnell and R. L. Hallett.

Expect to Begin Arkansas Operation During Summer

Midsummer has been set as the time of starting cement production at the new mill of the Arkansas Portland Cement Company at Okay, near Saratoga, Ark. Work on the plant has been completed and there remain only a few employees' buildings to be constructed.

The G. N. & A. railroad, owned principally by the Arkansas Company, has built a spur from Ashdown to the site of the plant.

Capital Increased

The Societe des Ciments Vicat, of Grenoble, has increased its capital from 22,000,000 to 27,000,000 francs.

Trophy Dedicatory Ceremonies Being Held

Dedication and unveiling ceremonies at the cement mills which won the Portland Cement Association safety trophy for 1929 are now being held.

Dates for the celebrations as announced are as follows: Cowell Portland Cement Co., Cowell, Calif., July 4th; Trinity, Dallas, Texas, July 4th; Alpha, Manheim, W. Va., July 6th; Canada, July 15th; Oregon, Oswego, Ore., Sept. 18th, and Wolverine, Oct. 10th.

Trophies have already been dedicated at the following: Consolidated Cement Corporation, Mildred, Kans.; Alpha Portland Cement Co., Ironton, Ohio, and Bellevue, Mich.; Marquette, Cape Girardeau, Mo.; Lehigh, Iola, Kans.; Bath, Foglesville, Ormrod, and Sandts Eddy, Pa.

Portland Cement Statistics in the Middle West

The Kansas City Cement Bureau, serving Arkansas, Kansas, Western Missouri, Nebraska, Oklahoma and Texas Panhandle, reports that the mills located in this territory shipped into same during the first quarter of 1929 a total of 1,307,725 bbls. of portland cement, as compared with 1,595,524 bbls. during the first quarter of 1928.

At the end of March, these mills had in stock 1,489,475 bbls. of finished portland cement, as compared with 1,465,224 at the end of March, 1928.

At the close of March, these mills had unshipped commitments on contracts for specific work in the above territory of approximately 986,000 bbls. of portland cement, as compared with approximately 917,000 bbls. at the end of March, 1928.

Torrance, Calif., Site to Be Developed by Paramount Cement Company

Applications for permits calling for the erection of three buildings south of Torrance, Calif., have been made by the Paramount Portland Cement Company. Five million dollars will be expended on the cement plant of which they will be a part.

Czechoslovakian Bank Founds New Cement Mill

The Banque Tcheque Union, of Prague, is promoting a new cement producing plant with a capital of 6,000,000 crowns.

New Reference Laboratory

for Testing Instruction

Laboratory for Testing of Portland Cement, Calibration of Machines and Instruments and Training of Men Is Established at Washington — Supported by A. S. T. M. and Federal Government—P. H. Bates in Charge

ESTABLISHMENT of a reference laboratory for portland cement is regarded by Robert P. Lamont, Secretary of Commerce, as one of the most important developments of recent years at the Bureau of Standards. Its functions include the testing of portland cement, calibration of machines and instruments used in cement testing and the training of men for commercial cement-testing laboratories. P. H. Bates, chief of the Clay and Silicate Products Division of the Bureau, has immediate supervision of the work.

Need for Laboratory

Establishment of the new laboratory is the outgrowth of a plan originally formulated by the cement committee of the A. S. T. M. Frederick W. Kelly, president of the North American Cement Corporation, as spokesman of the cement industry, addressed a letter to Mr. Bates, chairman of the cement committee, on September 15, 1928, calling attention to the need for such a laboratory. In this letter Mr. Kelly said:

"There are produced annually in the United States about 170,000,000 barrels of portland cement. Substantially all this cement is made to conform to the standard specifications for portland cement which have been adopted by the American Society for Testing Materials, by the U. S. government department and by the principal users of portland cement in the United States.

"It is necessary that all this cement be tested to make certain that it does conform with the standard specifications, and it is important that such tests be made to insure the integrity of the structures in which the cement is used. It is of vital importance to both the user and the manufacturer of cement that the tests be accurate, and that the results of tests on the same sample by two laboratories be the same.

"There are in the United States today probably 300 cement testing laboratories. Several series of carefully conducted tests have shown a lamentable lack of concordance in the results obtained even among the best of them. Differences of 100 per cent in results are not unusual. This introduces a most undesirable element of uncertainty into both the technical and the commercial ends of the cement industry, and is interfering with its development.

"Printed information and instructions have been made available to all interested in an unsuccessful effort to secure better results. It is believed that personal inspection and instruction are needed to secure a proper appreciation by all laboratories of the importance of machine calibration and exact compliance with specified conditions and methods.

"We propose to establish at the U. S. Bureau of Standards at Washington, a fellowship to be known as 'Reference Laboratory for Standard Cement Testing.' Under this fellowship, establish a laboratory with apparatus and personnel capable of making tests of portland cement in strict conformance with the specifications. This laboratory staff to be prepared to instruct on proper methods of making tests and maintaining testing equipment, also to calibrate all equipment submitted by laboratories as purchasers or by manufacturers of said equipment."

Information and Instruction

As a result of this letter the details were worked out for the establishment of the desired laboratory under the Bureau's research associate plan. The staff will consist of five experts, three of whom are now at work. This staff is prepared to furnish information and give instruction on established methods of testing, and on the proper maintenance of testing equipment, and will also calibrate such equipment submitted by purchasers or manufacturers.

Tests will be made of portland cement in strict conformance with the standard specifications and tests of the A. S. T. M. For the present it is planned to confine the work to physical testing. The instruction to be given by the laboratory staff will be of two kinds, one in the laboratory in Washington and the other in the field.

Scope of Laboratory Services

The scope of these services is described in the following announcement:

"One, in Washington detailed instruction will be given in the making of test specimens and in the methods of testing. Instruction will also be given in the maintenance of testing equipment and in checking the calibration of equipment.

"Two, in the field the instruction will consist principally of criticism of methods and conditions noted in each laboratory visited, and suggestions will be given for improving them. At the same time testing equipment in the laboratory visited will be calibrated where possible and instruction given in proper maintenance of equipment.

"The service will be available upon application only and will be rendered as nearly as possible in the order in which applications are received. Instruction in Washington may be expected to occupy two or more weeks, depending upon the aptitude of the men sent for training.

"The schedule of the laboratory representatives giving instruction in the field must obviously be arranged by routes to avoid unnecessary traveling. A couple of days only can be allotted to each laboratory on each visit.

"Application for service should be made to Cement Reference Laboratory, care Bureau of Standards, Washington, D. C."

The laboratory is planning to issue certificates covering the machines tested by it. All such certificates will be issued from Washington and the fees charged for this service will be in accordance with the schedules for similar work now in force at the Bureau. The money obtained will be deposited in the U. S. Treasury and will not be available for expenditure. A special committee of the main committee on cement of the American Society for Testing Materials has been appointed to cooperate with the Bureau of Standards in conducting the work of the reference laboratory.

Surveys History of British Cement Combine

An interesting review of developments past, present and to come in the business of the British Portland Cement Manufacturers, Ltd., the British combine, was made by P. Malcolm Stewart, chairman of the company, at the annual meeting held in London recently. Mr. Stewart said that the company was formed in 1912 by the Associated Portland Cement Manufacturers, Ltd., who, in order to finance the project, issued some £2,000,000 ($10,000,000) of 5 per cent second debentures, of which approximately £1,430,000 ($7,150,000) was utilized in subscribing for common and preferred shares at par. These operations were facilitated by a powerful financial group in London headed by Lord St. Davids who was the first chairman of the company, which was launched on sound lines, no promotion money or intermediate profit being taken by the promoters.

The amalgamation of interests effected was accomplished at a time when the industry had passed through a long period of depression, brought about by overproduction and price-cutting. The time was ripe for a further consolidation of the industry. The negotiations to this end were conducted with skill, resulting in a low purchase price for the properties acquired. In all no fewer than 41 portland cement, lime, and whiting works owned by 29 undertakings were purchased. For varying periods seven of these companies were retained as separate legal entities; finally all were liquidated and absorbed by the purchasing company.

The outstanding feature of the combination was that it co-ordinated the operations of no fewer than 58 individual works widely spread over the United Kingdom. Co-operation with the Associated Portland Cement Manufacturers, Ltd., with its powerful group of works on the Thames and Medway rivers, produced a combination full of opportunity.

It was not found an easy task to administer some 29 businesses. Perhaps the greatest difficulty was that with regard to sales policy. To find a solution of the problem as how to preserve the goodwill of the businesses purchased, to prevent competition between the many brands acquired, and, at the same time, attain the desired goal of selling the production which leaves the biggest margin of profit, was no easy task. Ultimately all these difficulties were successfully overcome through the formation by the A. P. C. M. and the B. P. C. M. of a central selling organization—the Cement Marketing Co., Ltd.—and the absorption by the British company of the assets of its allied companies, thus securely welding the separate interests into a single unit more easily controlled and more economically administered.

The British Portland Cement Manufacturers Company has been successfully operated from the outset, and has paid out £2,215,388 ($11,076,940) in common stock dividends, or an average of 9¼ per cent. Mortgages have been repaid and the amount of the debentures outstanding reduced.

During these 14 years there has been a steady improvement of the technical process of manufacture and a marked development in the plant employed. The productive capacity of the Johnson Works at Greenhithe on the Thames is being brought up to 8,400 tons weekly by the erection of two large rotary kilns, the provision of a much-improved clay supply, the concentration of the clinker grinding plant, and the supply on favorable terms of electric power from the Associated Portland Cement Manufacturers' Kent works. At the Wouldham works at Grays, on the north bank of the Thames, a large rotary kiln is being erected displacing five smaller units. Both the Johnson and Wouldham schemes will shortly be completed. Martin Earle's works have been completely reorganized, and with satisfactory results.

Further, it is hoped to complete this summer the works which are being erected at Hope in Derbyshire for G. & T. Earle, Ltd. Reinforced concrete bridges have been constructed to carry the railway siding over the main Buxton to Sheffield highway and over the River Noe.

The effect of these and other extensions will be to give the combine an annual productive capacity from efficient rotary kiln plants exceeding the aggregate production originally purchased in 1912, which included chamber and shaft kilns and a number of small rotary kilns now finally scrapped and replaced by modern units.

Soot Cleaning Data Rate Pulverized Coal Highest

Below are given figures collected by the Prime Movers Committee of the National Electric Light Association on the amount of steam used for soot cleaning.

Four classes of plants were surveyed: (1) Those using natural gas; (2) small stoker-fired boilers; (3) large stoker-fired boilers; and (4) pulverized fuel fired boilers.

A gas flame is known to be very clean. Gas burns without cinders and practically without soot. Hence the exceedingly small amount of steam required to keep gas-fired boilers clean.

Regarding the great difference in stoker-fired boilers, it is pointed out that the smaller ones are in older installations and consequently less efficient than the large modern plants. Also, the soot cleaning equipment on the smaller units is probably less effective.

The report shows that soot blowers on pulverized coal boilers are operated oftener than on stoker-fired boilers—two to three times as often. Of course, more soot and ash are carried along with the gases in pulverized coal boilers.

	Per cent of total steam used for soot blowing
Natural gas	0.0002
Stoker-fired (12,000 to 23,000 sq. ft.)	0.2
Stoker-fired (6,000 to 7,000 sq. ft.)	0.6
Pulverized coal	0.5

French Cement Firms Increase Capital for Expansion

The French cement firm, Compagnie Nouvelle des Ciments Portlands du Boulonnais, reports a profit of 2,074,185 francs for the past year.

The company, which recently absorbed the Ciments Artificials de Frangey, has decided to increase its capital from 20,000,000 to 30,000,000 francs and will soon begin construction of a new plant with an annual capacity of 60,000 tons.

Port Stockton Interests Acquire 1,000 Acres of Land

During the week of May 19th the Port Stockton Cement Company, Stockton, Calif., acquired by deed possession to nearly 1000 acres of land in the limestone belt northwest of the town of Columbia, near Sonora, Calif.

The property transferred comprises 160 acres of marble quarry, a former ranch of 640 acres, and 150 acres on a slope of the Stanislaus river.

The Cement Industry of Czechoslovakia

An Account of the Present Activities of Czechoslovakia in Cement Manufacture—Volume of Production—Type of Equipment—Raw Materials

By **THEODORE WOLFRAM**

THE young republic of Czechoslovakia, through the co-operation of its industries and the various government bureaus, is rapidly coming to the front as a manufacturing country. Although perhaps better known for its production of glass, porcelain and sugar, it is also an important producer of cement and cement products.

The cement industry is represented in Czechoslovakia by twelve mills, all of which produce an excellent grade of portland cement. Two of these establishments, the Kraluv Dvur firm in Bohemia and the Stramberk company in Moravia, also produce a mixed cement utilizing the slag from the blast furnaces of the steel mills.

Cement was first manufactured in Bohemia in the nineteenth century. The first cement mill was established at Bohosudov, near Teplice, in 1860. Between 1869 and 1872 mills were installed at Podoli, near Prague, and in 1870, Ferdinand Barta endeavored to manufacture cement at Hlubocepy. In 1872 the mill which he had founded at Radotin, through financial difficulties, passed into the hands of Max Herget. In 1921 a fusion of the ceramic manufacturers, Barta and Tichy, with the cement and lime mills of Max Herget at Zlihov and Radotin was arranged. The "Societe Miniere Tcheque" had previously founded a cement mill at Kraluv Dvur, near Beroun, where since 1889 cement was produced from the granulated slag from the neighboring blast furnaces under the trade name of "Charles Emile." This establishment, today the largest in Bohemia, has used rotary kilns since 1911. The first mill to employ this type of kiln was the "Societe Saxo-Bohemienne" at Cizkovice.

In Moravia the Count Maximilien de Seilern founded a cement mill in 1873 at Tlumacov; later on large factories were established at Stramberk, at Malomerice, near Brno, and at Hodolany, near Olomouc. Slovakia, in com-

The cement mill at Kraluv Dvur, near Beroun, Czechoslovakia, described briefly on the following page parison to its size, possesses but few mills, there being only those at Zilina and Ladce.

Plants Use Modern Equipment

The total production of all the mills is approximately 80,000 carloads per year. Their equipment has been more or less modernized. Four among them (those of Malomerice, Kraluv Dvur, Stramberk and in part, Cizkovice) are equipped with rotary kilns. Two mills belonging to the firm of O. Rosenberg (at Hodolany, near Olomouc and at Bohosudov, near Teplice) boast dump furnaces equipped with modern automatic "Thiele" gratings. The remaining mills (Podol, Radotin, Beroun and Tlumacov) have dump furnaces of different makes such as the Lieban, Dietz and Schneider.

The majority of these establishments secure their motive power either from steam plants or electric generators. The rotary kilns are heated with oil from Kladno or Ostrava and also with lignite from the Duchcov basin. The other mills employ, depending on the type of their equipment, coke or pulverized coal from the basins of the Ostrava or the High or Low Silesie.

At the present time Czechoslovakia produces only artificial portland cement made by mixing limestone and argile. The natural or "romain" cement exploitations have been abandoned. The quarries of limestone (Devonian and Silurian), extremely rich in excellent lime, are at the base of the Czech cement industry whose products are recognized as of first class quality even in foreign countries where they are imported in large quantities. As proof of this one can cite a large number of constructions in Germany, such as the huge pedestal of the monument, 23 meters high, at Leipzig, commemorating the soldiers of the World War. The mills at Cizkovice furnished the cement for this structure. Since the end of the war Holland has become an important market of the firm of O. Rosenberg.

The largest mill of Czechoslovakia, that at Kraluv Dvur, merits special mention. It is divided into four sections: The manufacture of cement from slag producing 9,000 carloads annually; the making of bricks from slag with an annual output of 20,000,000 bricks; the lime kilns (2 circular and 10 dumping); and finally the portland cement mill producing 6,000 carloads per year. The establishment possesses its own quarries of limestone which furnish it with various grades including the purest qualities (99 per cent), and an excellent lime for building mortar. A strata of grey-black argile, with the limestone, provides excellent raw material for a high-grade portland cement.

COMPONENTS OF THE KRALUV DVUR PRODUCTS

	Per cent Lime	Per cent Argile
Carbonate of calcium	84.34	59.56
Oxide of silica	9.20	25.82
Oxide of iron and aluminum	2.25	12.90
Carbonate of magnesium	2.03	-------

	Per cent
Oxide of calcium	65.42
Oxide of silica	21.26
Oxide of iron and magnesium	9.17
Oxide of magnesium	1.09
Oxide of sulphur	1.35
Loss through burning	1.42

The limestone quarries belonging to this firm are worked with pneumatic drills. A narrow gauge railway ten kilometers (approximately 6 miles) long serves to transport the raw material to the mills. The stone extracted from the quarries in the forests of Kosov are carried to the mills by cable lines.

This plant is very favorably situated along the railway line along a distance of 750 meters which facilitates the unloading of necessary fuel (about 6,000 carloads annually) as well as of the wood used in the making of the barrels in which the cement is packed. The mills possess four tubular boilers, Rantenkranz-Suchay, with a heating surface of 208 square meters and a pressure which at 15 atm. can be brought to 400 deg. The coal is burned on automatic grates of Pluto-Stoker Company make, with the aid of steam bellows. The fuel arrives automatically from elevated reservoirs operated electrically by two turbine generators, A. E. G. Curtis make, capable of providing 1,700 k.w. at maximum. The total consumption of alternative current, for motive power and lighting, runs from 6,000 to 7,000 k.w. The cement is fabricated in rotary kilns 42 meters long installed by F. L. Smidth and Company of Copenhagen, Denmark. The products of Kraluv Dvur rank among the highest grades of portland cement.

The fine quality of the lime deposits also assures the other Czech firms excellent products. During 1918-1921 the firm of O. Rosenberg invested a large amount of capital in its two mills at Bohosudov, in Bohemia, and at Hodolany, in Moravia. The Schneider furnaces have been equipped with the Thiele system of automatic grates and mechanical carriers for bringing in the raw materials and carrying off the waste. This equipment proves as satisfactory as the rotating furnaces, costs less to install and keeps down the cost of production.

More than 300 establishments are engaged in the manufacture of cement products in Czechoslovakia. Among the articles produced are tiles, grey and colored floor tiles, pipes, small columns and stair steps. Most of these articles are made with hand-presses or molds. Cement products are in great demand in the farming districts. The Kerament firm of Bratislava has launched two new products: building slabs of cement and cement building tiles with a glazed surface.

During late years the manufacture of artificial roofing of waterproofed cement has developed into a flourishing industry. This industry was founded at Vocklabruck, in Lower-Austria, under the Hatschek patent. When this patent ran out the industry spread into Bohemia, Silesia and Moravia where at least ten factories now produce this roofing. One of the most modern of these plants is that of Hradec Kralove which employs 120 workers and produces 2 carloads of roofing per day. The production of waterproofed cement is highly developed in Czechoslovakia and much of this material is exported.

Increased Output of Masonry, Natural and Puzzolan Cements in 1928

Statistics of hydraulic cements, other than portland cement, in 1928, which include masonry, natural and puzzolan cements, as compiled by the United States Bureau of Mines, Department of Commerce, show that the production—2,210,404 barrels—exceeded that of 1927 by over 4 per cent. Shipments of these cements from mills in 1928 increased over 2 per cent in quantity and over 1 per cent in gross value. Stocks at the mills decreased and were about 2 per cent lower at the end of 1928 than at the end of 1927.

These statistics represent the output of 11 plants, which are located as follows: One each in Alabama, Illinois, Indiana, Kansas, Kentucky, Ohio, and Pennsylvania; and two each in Minnesota and New York.

The output has been expressed in terms of 376-pound barrels to correspond with the statistics of portland cement.

Masonry, Natural, and Puzzolan Cements Produced, Shipped and in Stock in the United States, 1927 and 1928

Year	Active Plants	Production Bbls.	—Shipments— Bbls.	—Shipments— Value	Stock (Dec. 31) Bbls.
1927	11	2,123,868	2,158,323	$2,881,029	143,854
1928	11	2,210,404	2,213,645	2,910,097	140,613

EDITORIAL

A Plant Efficiency Trophy

THE benefits that have followed the sustained safety educational campaign in the cement industry are evidence of what can be accomplished by a campaign that appeals to the initiative of the officers and workmen for its results. The element of competition between the various plants operated by a single company and the various manufacturers is an additional incentive toward accomplishment.

A similar campaign to increase operating efficiency might prove equally successful. Already labor statistics are being collected and tabulated and it would not be a difficult matter to use these as a basis for the award of an operating efficiency trophy. The difficult job of getting manufacturers to report their statistics is already accomplished.

Already there is a great deal of competitive interest in the labor statistics and some manufacturers who operate a number of plants are using them as a basis of competition between plants. The fact that the safety competitions have been operative for a number of years has taught the plant foremen and the laborer to work together for a common goal. These same men would compete for the plant efficiency trophy.

Why not a plant efficiency trophy?

The Manufacturer's Point of View

AMONG the many valuable services rendered by the American Society for Testing Materials to the engineering profession is its frank recognition of the value of the manufacturer's views. The manufacturer's viewpoint is as important in the formulation of standard specifications as are the wishes or demands of the user. The progressive, constructive course is seldom found in either extreme.

The stimulating influence of the user is needed to urge the manufacturer to higher standards. The caution of the manufacturer is equally necessary to prevent ill-advised and impossible changes. Both user and manufacturer are represented in any action taken by the American Society for Testing Materials.

It is fortunate that this is the case in the problem that now confronts Committee C-1 on Cement. A new specification for high early strength is assuredly needed and perhaps another upward revision of the standard specifications is not improbable.

Most cement manufacturers have produced a product considerably above the standard requirements during the past year. They have done this to stimulate the sale of their particular product and to provide a margin to account for the "human equation" in cement testing. Some manufacturers have far exceeded the standard requirements knowing that they could produce a higher quality cement competitively. Probably the bulk of the manufacturers could produce a cement that would meet specifications with advanced early strength requirements. It would work no hardship on them to revise the standard specifications upward.

With the new cement testing reference laboratory it may be possible to allow a narrower margin between cement laboratory and commercial laboratory results. But the question of how much in excess of the standard requirements the manufacturer must hold his product in order to be on the safe side is one that must be considered in any recommendation the manufacturers may make.

The user has already been encouraged to expect a higher quality of cement. And the cement manufacturer himself is the cause. He has convinced the user by his sales arguments that the specifications can be exceeded by a large margin at no extra cost to the user.

These conditions cannot help but influence any consideration of specification revision. The manufacturer's action in supplying such cements will be, in a measure at least, interpreted as his point of view on the matter.

Real Progress

THE establishment of a reference laboratory for portland cement testing methods at the U. S. Bureau of Standards constitutes a very definite step forward and paves the way for further progressive action.

All of the organizations having a hand in this movement deserve commendation. It is not often that a project of such importance is agreed upon and translated into action as quickly as this was, especially when a number of organizations are interested.

The need for a reference laboratory for the purpose of instructing on established methods of making tests and proper methods for maintaining testing equipment was forcibly shown in the facts presented in the report of Committee C-1 last July. Clearly the first need in the matter of cement specifications was a dependable means for measuring the specification requirements. Without this any revisions in the specifications would lose much of their significance.

Now that definite action has been taken and the new laboratory is functioning, the committee can turn its attention whole-heartedly to the problems presented by the already firmly established special cements. Action as constructive and as direct as that on cement testing is needed.

Lehigh Mills Represented 100 Per Cent at Regional Safety Meeting

Enthusiasm Brings Out Record Attendance to Pennsylvania Safety Meeting — Quarry Film Shown — Safety Flags Distributed

OVER three hundred persons attended the annual regional safety meeting for Lehigh Valley cement mills held at the Americus Hotel, Allentown, Pa., on May 23rd. Every mill in the region was represented.

R. B. Fortuin acted as chairman, and opened the program by introducing A. J. R. Curtis, assistant to the general manager of the Portland Cement Association. Mr. Curtis' message was comprised of a few words from headquarters. Second on the program was the introduction of delegates representing plants who were 1928 trophy winners. Each delegate spoke a few words.

Quarry Film

A motion picture film entitled "The Quarry Industry of Pennsylvania" was shown by Thomas Quigley, chief of quarries, Commonwealth of Pennsylvania. In a short talk preceding the film, Mr. Quigley said, in part:

"No other industry in this great Commonwealth has been more active in Accident Prevention Work than the Cement Manufacturers of Pennsylvania. The records made by your industry are postive proof of what can be done to protect life and limb when men and management cooperate 100 per cent for the elimination of accidents.

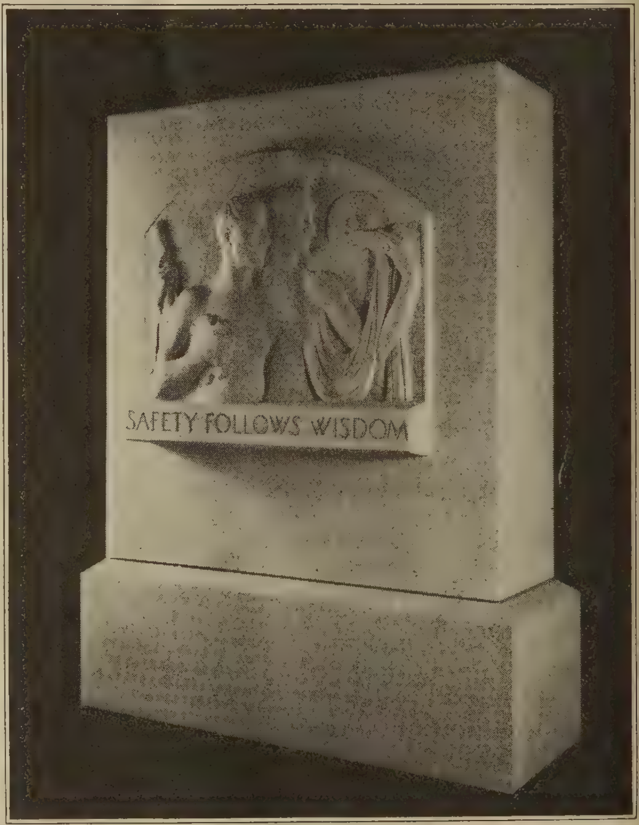
"The most serious problem confronting industrial managers today is the prevention of accident. A careful study of industrial accident statistics shows us that 75 per cent of all accidents are preventable. Your Association has proven that through real safety work accidents can be reduced to a minimum. You have been pioneers in the safety movement and the records made by you have encouraged others to follow in your footsteps.

"While the accident prevention campaign is only in its infancy, I am confident we are on the right road, and in a few years we will be able to point with pride to the remarkable reduction in industrial accidents in Pennsylvania, and no other industry in this commonwealth deserves greater credit for having spread the gospel of accident prevention than the cement manufacturers.

Discussions

John Roach, deputy commissioner of labor, State of New Jersey, then told of his "Experience with the Safety Problem." His talk was followed by a round table discuscussion on "Are We Getting the Most Out of the 'Significant Accident Bulletins'?" The latter is a list of accidents distributed monthly by the Portland Cement Association. Discussion brought to light the need for more complete information than is now provided by the bulletin. Members were asked to report accidents more fully and it was suggested that the association enlarge upon its reports.

The purpose of the discussion was three-fold, and the second subject to come before the meeting was the value of investigating and analyzing the cause of accidents, which amplified to some extent the developments of the first. A number of suggestions for reducing accidents in the fall months of operation developed in the course of discussion of the last and third subject.



The Portland Cement Association safety trophy, awarded annually to plants having accident-free records

D. Adam, presiding as chairman of the dinner, introduced Major H. A. Reninger as toastmaster. The latter called upon A. J. R. Curtis to present each Lehigh Valley mill with its "June No-Accident" flag on behalf of the Board of Directors of the Portland Cement Association.

Orchestral music was furnished by courtesy of the Nazareth Portland Cement Company.

New Castle Meeting

The Scottish Rite Cathedral at New Castle, Pennsylvania, was the scene of another regional safety meeting on June 18th. The paper appearing below is one of those presented at that meeting. A third will be held at Detroit, Michigan, on July 9th, at the Book-Cadillac Hotel.

May 11th marked the close of the third year during which the Cowell Portland Cement Company's plant at Cowell, Calif., operated without a lost-time accident.

A general safety first meeting was held on Thursday at the Coplay Cement Manufacturing Company's plant at Coplay, attended by practically all of the company's employes and was presided over by William F. Nagle, chairman of the company's general safety committee. He spoke to the men on the subject of "Accident Statistical Facts."

D. J. Uhle, operating manager, spoke on the subject of "Plant Accident Experience and Organized Safety."

T. J. Quigley, chief of the quarry section of the Department of Labor and Industry, of Pennsylvania, was next introduced. He spoke on "Accident Prevention and Cooperative Plant Management," mentioning the activities of the State Department of Labor in its efforts to safeguard the working conditions of the employe.

H. E. Mick, assistant operating manager of the plants, spoke to the men. He asked for their renewed efforts in accident prevention work.

924 Days Without An Accident

Alpha Superintendent Tells How the Ironton Plant Has Achieved Its Enviable Record—Goggles Given Share of Credit—Foremen Found Best for Contact—Bonus Policy Effective

By F. C. BROWNSTEAD, SUPERINTENDENT
Alpha Portland Cement Company, Ironton, Ohio.

THE fact that the Ironton plant of the Alpha Portland Cement Company has gone through two successive years without a lost-time accident has made it the recipient of many inquiries as to the manner in which we carry on our safety activities. Like all other organizations we are constantly experimenting and the methods we use today may be discarded tomorrow, so it is impossible to lay our inger on any one thing and say it is responsible for our success.

Regardless of what methods are used the whole secret lies n the two words: "Education" and "Cooperation." These words have been used so often that they may sound monotonous but the fact remains that they are the foundation for all accident prevention. No one will question the statement that nothing can be accomplished without cooperation. Years ago many of the officials and plant superintendents were lukewarm toward safety and as a result but little progress was made. You can never create enthusiasm among employees over anything unless they are shown by word and deed that the management is sincere. The spirit of Safety is *only* contagious when it starts at the top and works downward.

Importance of Education

In regard to the other half of our prescription, "Education," we must make our fellow workmen realize that accident prevention is not primarily a question of dollars and cents, but of saving human life. It is attempting to prevent men from losing eyes, arms and legs which can never be put back. It is trying to save the making of widows and orphans, destitution and misery. Neither our officers nor the laws can do it but we ourselves can do it if we but try.

We all know that most accidents are preventable; that they are due to carelessness or thoughtlessness, to unlawful practices on the part of workmen and not to defective machines. It should not, therefore, be taken for granted that every man does know the safe and unsafe ways of doing his work; neither should we assume that without any special instruction he will of his own accord take the safe course. Many accidents are undoubtedly caused by sheer carelessness, yet how often would, what on the face of things appears to be carelessness, turn out to be simply ignorance; ignorance as a result of lack of instruction.

The safety work at the Ironton plant is not carried on by a safety supervisor or anyone hired especially for this purpose. Our safety committee is composed entirely of foremen or heads of departments. Considerable experimenting was done and various combinations were tried in order to get the best committee possible, but we found that the foreman is the logical man to have on the committee, in fact, we made but little progress until we placed the responsibility on the foremen.

Monthly Meetings

Our regular meetings are held once a month with additional meetings called whenever it is deemed necessary. After a shut-down period we call all the men together a day or two before the plant is started for a general meeting. Several outside speakers are usually obtained for this occasion and they remind the men that they may be a bit rusty due to their layoff and urge them to be careful.

Until 1928 all of our regular meetings were in charge of the chairman of the committee but last year we gave each foreman charge of one meeting. This man is chairman of the committee for one month and is in charge of all safety activities during that month. Aided by the men in his department he makes all inspections, investigations, etc. We found that this arrangement created a friendly rivalry that made each foreman anxious to add another clear month to our safety record. It also makes the foreman in charge feel an added responsibility and makes him take a greater interest than ever before.

Our meetings, too, were more varied and interesting as each foreman would add something unusual to his program. For example, our mine department brought in their first aid team and put on a first aid demonstration. The power department organized a quartette and sang a safety song, the words and music of which were written by the power department foreman.

Of all the phases of safety work there is none, we believe, having a greater appeal than that of eye protection. In the loss of a finger, a hand, an arm or a limb there is, of course

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Paper presented at the regional safety meeting of the Portland Cement Association at New Castle, Pa., on June 12th.

the element of tragedy, but not the deep, pathetic tragedy that shrouds a life in darkness when the priceless possession of sight is lost.

Goggles Made Compulsory

The Ironton plant, we believe, was one of the first to equip each man with a pair of goggles and make the wearing of them compulsory. Prior to 1925 we were having a great number of eye accidents; men were being struck by flying chips of stone and steel and losing the sight of an eye. So a compulsory goggle rule was put in effect in April, 1925. Each man was given a pair of goggles and a letter explaining the reason for giving them and also instructions as to when they must be worn as well as the penalty for not wearing them.

These goggles were purchased by the company at $1.10 per pair and this amount was deducted each man when he received his pair. The company keeps the goggles in repair free of charge and when a man leaves the service his $1.10 is refunded to him providing he returns the goggles, no deduction being made for the condition of the goggles when they are returned.

In the beginning we had some trouble getting the men to wear their goggles and we were given all the stock excuses such as: "I can't see through them," "They give me a headache," etc., but we kept driving away and each time a man turned in a pair of the glasses which were shattered by flying chips or were covered with exploded metal we put them on our bulletin board with a full description of just how near so and so came to losing his eyesight. Such advertising proved a big help and now it is a rare case to have to call a man's attention to his goggles. We cannot say how many eyes have been saved or how many lost-time accidents have been averted by this rule, but we do give the goggles a big share of the credit for the record we have made.

It is impossible to place too much emphasis on the part played by the plant doctor in holding down the number of lost-time accidents.

Periodical Examination

It is the rule at our plant that every new man must be given a thorough physical examination before he goes to work and every old man is given a periodical examination. By this arrangement the unfit are kept out of our plant and a line is kept on our regular men so that if anything develops which might make them unable to take care of their regular job as they should, they can be transferred to another job which they can handle safely.

The real company doctor is one in whom the men have confidence. He should be a ready and sympathetic listener to all their troubles, both real and imaginary, so that the men will be anxious to come to him for treatment and advice.

Many men think it effeminate or babyish to run to the first aid room for every little scratch and the plant doctor can do more to correct this idea than anyone else. Infection, which may follow the most innocent looking scratch, is responsible for more lost-time than any other one thing and will continue to be so unless the men can be educated to the importance of first aid.

We make every effort to keep a man from losing time but we do not insist on a man staying on the job if he is not able to work. Neither do we allow a man to sit around and do nothing merely to keep our record intact. If a man receives a slight injury which may handicap him on his regular job we transfer him to some other job temporarily but under no circumstances do we create a job for him. In our desire to establish records, win trophies, etc., we are apt to forget that our fight is to eliminate accidents and these records and trophies mean nothing if we have not reduced not only our lost-time accidents but also the number of our no lost-time accidents.

We of the Ironton plant feel greatly indebted to the Portland Cement Association and to them should be given no small share of the credit for the record we have made. In our opinion the monthly report entitled "Significant Accidents" is one of the most valuable bits of information put out by this organization. This report is given a thorough study in our committee meetings and an attempt is made to visualize each accident described or in other words we imagine the injured man as being one of our men. If we find that a similar accident is liable to occur at our plant we take immediate steps to head it off.

Each foreman is given a copy of this report and in addition to this we make another report covering the accidents which are peculiar to his department. The latter report is first read and explained to his men and then placed on the department bulletin board.

After all has been said and done there is nothing that so impresses the men that their company is really trying to cooperate with them in the reduction of accidents as a little addition to their pay check. Banquets, barbecues and entertainments that may mean the outlay of five or six hundred dollars serve the purpose but it has been our experience that a hundred dollars distributed among all the men gives far better results.

Bonus Plan

The Alpha plan is to add to each man's check 1 per cent of his earnings whenever the plant goes through a month without a lost-time accident. This bonus, of course, does not amount to much for each man but still it means quite an outlay for the company in a year's time for all of our plants. The average monthly bonus per man at our plant would be about $1.25 but it is surprising how our men count on this addition and how they appreciate it.

Our men have now earned this bonus for thirty-one consecutive months and have gotten so used to it that I would be sorry for the fellow who caused it to be cut off through some careless or thoughtless act.

Any report on the safety activities at our plant would not be complete without a word or two regarding our mine department. Our stone is obtained in a shaft mine 560 feet below the surface and this department employs in the neighborhood of 60 men. The light, of course, is all artificial and safeguards can only be installed in comparatively few places, such as on loading machines and locomotives. The record made in this department proves what we have said regarding the importance of education for it is only by means of constant watching and thinking that accidents have been eliminated.

Another thing of which we are proud is that this shaft was lined with concrete from top to bottom this winter without an accident. This was a most hazardous undertaking and would have to be seen to be appreciated.

In conclusion, we might say that the record we have made was not due to any elaborate program carried on at our plant. The methods we use are similar to those used in most plants and the 924 days we have gone without a lost-time accident only serve as an inspiration for even greater accident prevention effort in the future.

Ventura, Calif., New Site for Proposed Plant

Negotiations are under way between the family owning mineral deposits on a ranch north of Santa Susana, near Ventura, Calif., and J. L. McPherson, civil and mining engineer of Seattle and representing a northern cement company, for the possible purchase of a cement plant site.

Mr. McPherson has recently been engaged in determining the feasibility of extending a spur branch of the Southern Pacific Railroad to the proposed location.

It's the Little Things That Count

Some Practical Pointers on Steam Shovel Maintenance

By RUSSELL BYRON WILLIAMS

ILLUSTRATED here is a gasoline shovel handling blast furnace slag at the plant of the Universal Portland Cement Co. in Minnesota. By merely looking at the unretouched photograph or by visiting a similar job one could not tell where were details that needed attention. To force home the realization of the importance of minor details and the insidious menace of all small leaks I have indicated by arrows and numerals a few places that commonly harbor cost boosters. Those indicated are by no means the only ones that can infest the average similar operation. These have been selected merely to afford an example of the losses that can be and are being sustained by literally hundreds of shovel operators throughout the country.

1—All sheave bearings should be constantly watched for alignment and wear. Lack of proper lubrication at this point imposes unnecessary wear and rapid depreciation, while the constant side swinging of the loads are a constant strain on sheave alignment—and incorrect alignment means high mortality for rope and sheaves.

2—Watch the sheave grooves. If they are worn, excessive abrasion is set up and the outer wires of the rope will be subjected to undue wear and early breakage. If the sheave is not of the proper size the rope will be pinched—and a pinching sheave can do more damage to a wire rope in one hour than a proper sized sheave could possibly do in an entire month—and that is no exaggeration. Sheaves are more easily replaced and much cheaper than good wire rope.

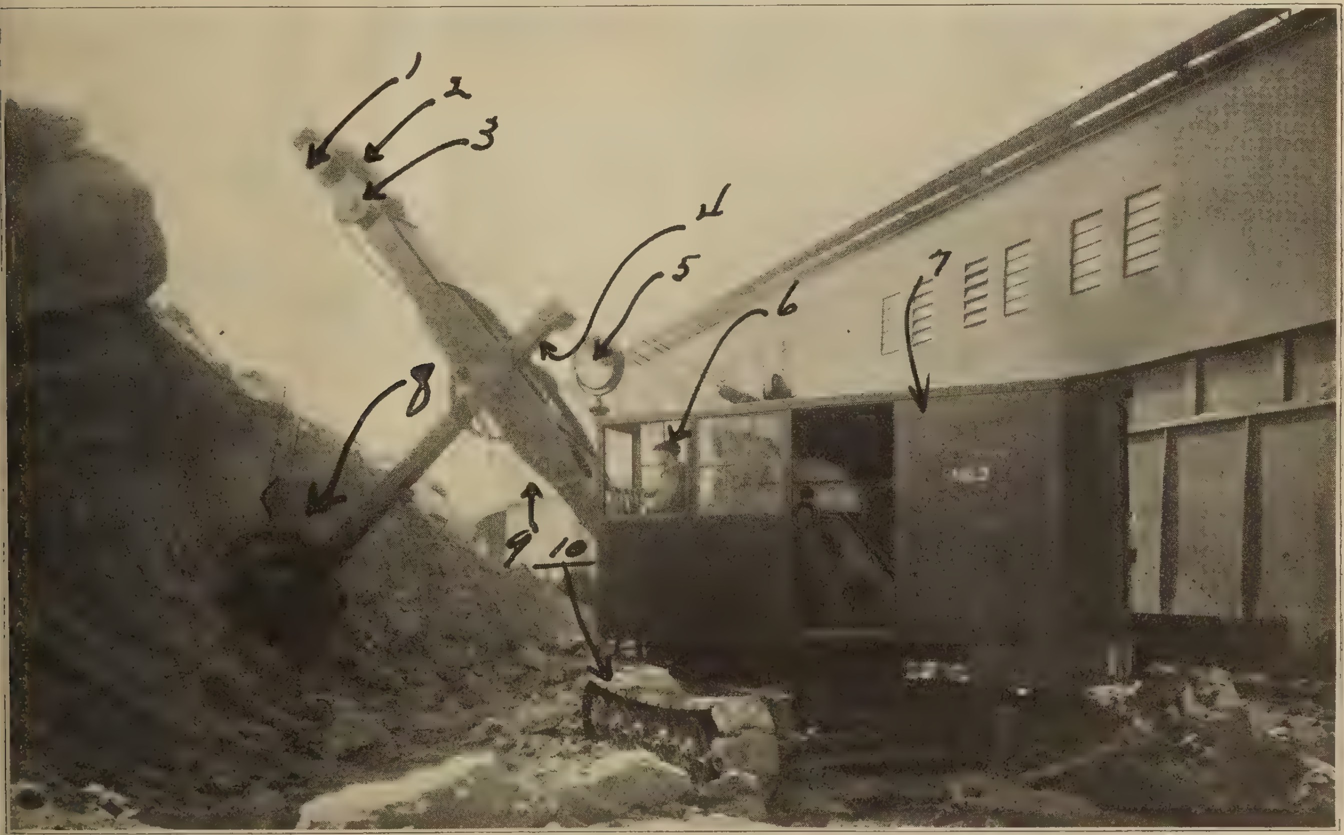
3—Chains should be kept well lubricated at all times. Their frequent inspection is also necessary because of the old adage "a chain is no stronger than its weakest link" and the fact that the unlooked for failure of a single link may cause serious damage or injury.

4—Gears that have become worn or teeth that are slightly chipped require much greater power than is demanded of gears that mesh properly. Lubrication at this point means long life and satisfactory service—but lubrication can also mean needless expense, if the correct type of grease or oil is not used.

5—A layer of dust over this lens, or which might have filtered into the lamp and settled on the reflector or bulb, will reduce the quantity of light by an astonishingly large percentage. If bulbs burn out and the replacements are not of the proper construction there may develop expense either through repeated destruction of the bulb or loss of lighting efficiency.

6—If this operator should get into the habit of slowing up or stopping at 4:45 instead of 5 o'clock, he will, over the course of a 300-day work year, waste 75 hours of production time.

7—Metal surfaces should be given a coat of anti-rust at least once in every six months. There are a number of excellent coverings on the market—some better adapted to



Some points in steam shovel operation that are common cost boosters are numbered above and explained in the article particular uses than others. Consult a recognized authority or call in the representative of an established firm who advertises.

8—Keep the dipper teeth sharp and full. A dull, chipped or broken tooth on the dipper will demand as much as 50 per cent additional crowding power—and power is nothing more than fuel, in finished form.

9—Look to the lubrication of the wire rope. At the factory its core has been thoroughly impregnated with the proper lubrication and the wires given a good coating of heavy lubricant. The dust and dirt and wear of daily operation, however, soon nullifies the value of this preparatory lubrication. A properly lubricated rope will last from three to four times as long as one that is neglected.

Wire rope should not be handled in a manner similar to that of rubber hose or hemp rope. Wire rope, not of the preformed type, will kink readily and once a kink has been formed no amount of strain will ever get it out. In changing from the shovel to the crane boom or vice versa, the rope should be handled by lifting the coil to its edge and rolling or unrolling along the ground.

10—Crawler treads are difficult to lubricate. In spite of any difficulty, however, they should be given good care since they not only bear great weight but are continually grinding against abrasive dirt, sand, gravel and other destructive elements.

A. S. M. E. to Celebrate Its 50th Anniversary in 1930

The fiftieth anniversary of two gatherings held in February and April of 1880, which resulted in the formation of the American Society of Mechanical Engineers, will be celebrated in 1930 with ceremonies international in scope. They will record the achievements of the Society for the past fifty years, evaluate the influence of mechanical engineering upon the social and economic life of the country, and point the way to future development. It is expected that the five days, April 5th-9th, 1930, will be given over to the celebration.

The preliminary meeting of the Society on February 16th, 1880, was held in the office of the "American Machinist." It is fitting, therefore, that the proceedings start in New York with a visit to the present office of the "American Machinist," where appropriate ceremonies will be held. The organization meeting was held on April 7, 1880, in the auditorium of Stevens Institute of Technology at Hoboken, and on the second day of the celebration in 1930 the scene of this first meeting will be visited. Stevens Institute is preparing an elaborate pageant which will depict the early life of the Society. The final three days of the celebration will be held in Washington, D. C., with a program of speakers from other nations.

Invitations have been issued to the engineering societies and engineering schools throughout the world to send delegates to the event.

Cement Demand

In spite of the fact that the demand for cement was seventeen times as great in 1928 as in 1900, the industry in its entirety is far from prosperous, due to foreign competition, is the essence of an article appearing recently in a financial periodical.

Production, it continues, does not exceed 85 per cent of plant capacity and 8 per cent of the total American production in 1928 was sold at a loss.

Monolith Stock on Los Angeles Exchange

Monolith Portland Cement Company preferred and common stocks which have just made their appearance on the Los Angeles Stock Exchange earned during the first quarter this year, net profits equivalent to 58 cents a share on the 225,000 shares of no par common stock outstanding after all charges including preferred dividends, Coy Burnett, president, announced recently.

The earnings available for the 8 per cent cumulative preferred stock, of which there are 150,000 shares of $10 par value outstanding less 119 shares held in the treasury, were 5.3 times dividend requirements, and amounted to $160,422.35. This is an annual rate of $641,689.40 which compares with $375,780.20 earned in the full year 1928. The 1928 profits were equal to $1.71 a share on 150,000 common shares then outstanding.

The company is engaged in a program of improvements costing about $750,000 of which $500,000 has already been expended, which it is believed will materially reduce manufacturing costs, Mr. Burnett stated. These improvements are estimated to save $225,000 annually, equal to $1 a share on the common stock.

Idaho Plant Begins Operation

The first cement to be manufactured at the new Idaho Portland Cement Company plant, at Inkom, near Pocatello, Idaho, was turned out on June 15th.

Officers and directors of the concern are: E. J. Simons, president; J. B. Maxfield and J. H. Neill, vice-presidents; A. J. Lindsay, secretary; J. Thomas O'Brien, treasurer, and Eugene Enloe and N. J. Dolph, directors. Mr. O'Brien will be sales manager.

National Begins Installation of Machinery

Installation of machinery in the plant of the National Portland Cement Company at Houston, Texas, was begun early in June, and it is expected that the manufacture of white cement will be started within the next few months.

French Cement Mills Install Modern Machinery

The French cement manufacturer, Poliet and Chausson, is installing in four of its mills the latest models of fuel pulverizers, Resolutor, manufactured by the Societe des Appareils de Manutention et Fours Stein. The mills being equipped are those at Gargenville and Cantin, in France, and those of Casablanca and Dakar, in Africa. Several other French firms are installing similar equipment.

Bessemer Warehouse for Toledo

Sometime during 1929 the Bessemer Limestone and Cement Company and the Peerless-Egyptian Cement Company will erect a large cement warehouse at Toledo, Ohio. Details have not been announced.

Increase in Capital

The French cement firm, Societe Colonialle des Chaux et Ciments Portland de Marseille, has increased its capital by the issue of 7,500 new shares of 100 francs par value.

Burning Sequence

Reaction of Lime with Argillaceous Constituents During Progressive Heating of a Cement Mix—Report No. XXVII of the Cement Institute at the Berlin Engineering School — Tests by Dipl. Ing. Hans Lorenz; Reported by Prof. Dr. Hans Kühl, in Zement.

IN SPITE of some outstanding achievements, the mineralogical researches of the chemical composition of portland cement have failed to clear the problem, and it seems logical to return to chemical methods in seeking the solution of the remaining points.[1]. It is also necessary to establish the reasons which stand in the way of ultimate success of mineralogical investigations.

Since LeChatelier and Tőnebohm first described the mineral structure of portland cement clinker, it has become one of the most important tasks of scientific cement research to provide the fundamental basis for the solution of the constitution problems through a careful study of the equilibrium within the ternary system lime-silica-alumina. The most liberally endowed researches carried out by American scientists at the geophysical laboratory of the Carnegie Institution[2] have dealt with this phase of the problem so thoroughly, that only minor corrections have been made since in the diagram thus established. However, the conclusions which they drew concerning the constitution of portland cement clinker failed to conform to the experience of practical cement chemistry. The author has pointed out at an earlier date[3] that portland cement clinker does not present as its main constituents tricalcium-silicate, dicalcium-silicate and tricalcium-aluminate, as assumed by these investigators on the basis of their study of the three-component system.

Jäneckeit

Part of the three-component system lime-silicate-alumina was investigated by Jänecke almost at the same time as these researches were being carried out in America. Near the lime vertex of the three-component diagram Jänecke discovered a new compound, $8CaO \cdot 2SiO_2 \cdot Al_2O_3$, which was thereupon designated as Jäneckeit. Although since that time the existence of this compound has been frequently doubted[4] the author believes that an exhaustive knowledge of all data establishes this existence so definitely, that Jäneckeit can by right claim an important part in the structure of portland cement clinker.

Unfortunately, Jänecke was unable to evaluate his discovery. He first believed that Jäneckeit was identical with the alite of portland cement clinker; thereupon he was of the opinion that alite was a mixed series of dicalcium-silicate and Jäneckeit.[5] The author believes to have proven the divergence of this view from the test evidence of silicate chemistry.[6] The present investigations show also that this view contradicts the processes of clinkerization. It may be pointed out at this time, that Jänecke's latest conclusions regarding the "optimum" composition of portland cement clinker[7] contradict his definition of alite; the values obtained on the basis of his theory of the "optimum" composition of portland cement contradict practical experience. A cement containing 21.3 per cent silica, 8.0 per cent alumina and 2.0 per cent iron oxide, must certainly contain more than 63.7 per cent lime, if it is to justify the designation of "optimum" composition.

Recognizing that portland cement clinker does not represent a stable condition, Nacken and Dyckerhoff[8] concluded that its constitution could not be deduced from the equilibrium diagram of the three-component system, and reasoned that a study of the conditions under which the compounds of the three-component system are formed would lead to the solution of the problem of the constitution of portland cement clinker. The familiar investigation by Walter Dyckerhoff, which can be placed on a level with the American investigations due to its wealth of scientific material, has provided some valuable new viewpoints in approaching the clinker problem. Yet it is the author's opinion that even Dyckerhoff has not sufficiently valued the experience of cement chemistry in his conclusions, drawn from investigations of pure compounds of lime, silica and alumina.[9] For when Dyckerhoff pronounces alite to be a dicalcium-silicate combined with lime, his opinion is as unacceptable to a cement chemist, as Jänecke's interpretation of alite as a mixture of dicalcium-silicate and Jäneckeit. The author believes that in both cases the contradiction of scientific test evidence with the exactions of practical cement chemistry depends to a large extent on the neglected iron oxide.

Iron Oxide

The earliest cement researches have recognized the importance of iron oxide for the sintering of portland cement, although at the time it was hardly realized that iron oxide is not only of utmost importance in practical cement calcination, but that it holds the solution of many a scientific problem as well, as the author believes.

When Dyckerhoff establishes, for example, that dicalcium-silicate begins to form rapidly enough to ascribe to the reaction any importance at all only at temperatures over 1100 deg. C., and finds that monocalcium-aluminate reaches this point only between 900 deg. C. and 1000 deg. C., this only goes to prove that it is impossible to apply the evidence of observations made on pure compounds to the reactions taking place in the cement mix containing iron oxide. It is beyond doubt, that in heating a cement mix the formation of new calcium silicates and calcium aluminates sets in at temperatures far lower than the above, obtained by Dyckerhoff with pure compounds. Not long ago, it was shown by Monath[10] that this new formation of calcium silicates and calcium aluminates sets in already at 730 deg. C. and reaches a considerably active stage at 800 deg. C. to 850 deg. C. The reactions, which take place in the cement mix at such low temperatures, leave one groping in the dark, if one tries to fit them to the observations made by Dyckerhoff on pure compounds.

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[1] H. Kühl, Latest on Alite, *Zement* 1928, p. 1303.

[2] G. A. Rankin, *Zeitscher. f. Anorg. Chem.* 92, 1915, pp. 213-296.

[3] H. Kühl, Hydraulic Hardening as Colloid Chemical Problem. *Zementprotokoll*, 1922, p. 103.

[4] Hansen, Dyckerhoff, Ashton and Bogue; *Zement* 1927, p. 51.

[5] *Zementprotokoll*, 1928, p. 29, footnote.

[6] *Zement*, 1928, p. 1303.

[7] *Zement*, 1929, p. 292.

[8] W. Dyckerhoff, "On the Conditions of Mineral Formation During Heating of Mixtures of Lime, Silica and Alumina," *Dissertation*, Leipzig, 1925.

[9] *Zement*, 1927, p. 869.

[10] *Revue des Mat. de Constr.*, 1928, No. 3.

Upon a suggestion from the author, Dipl. Ing. Hans Lorenz undertook the measurement of free lime at different temperatures to provide data on the progressive reaction of lime, as it goes on in actual practice during calcination of the cement mix. Lorenz used the same methods, which were used by Monath, replacing, however, the temperature measurements by means of Seger cones by temperature measurements with a platinum-rhodium thermo-element, so that higher temperatures could be dealt with and processes taking place before and during sintering could be observed with the ultimate purpose of drawing conclusions concerning the constitution of portland cement clinker and, particularly, on the formation of alite.

Determining Free Lime

Free lime in portland cement clinker can be determined by two methods, known as the White[11] and the Emley[12] processes, of which one yields a qualitative determination of free lime, while the other permits a quantitative determination of the same.

In using White's method, a small quantity of pulverized clinker is mixed with a solution of phenol in nitrobenzol, to which a trace of water has been added, and is placed under the microscope with crossed nicols; if free lime is present, needle-shaped crystals with strong double refraction begin to appear. The reaction takes place at a rate directly proportional to the quantity of free lime present, so that the time interval between the preparation of the specimen and the appearance of the first crystals, as well as the further interval up to the termination of the reaction, permit an estimate of the quantity of free lime. If no needle-shaped crystals appear within the first quarter of an hour, no free lime is present.

In Emley's method, 0.2 to 0.3 gm. cement are mixed in an Erlenmeyer flask with a solution of 6 cc. glycerine in 30 cc. absolute alcohol and the mixture is brought to the boiling point, the free lime reacting with the glycerine to form a glycerate. The precipitate is titrated, using phenolphthalein as indicator, with an n/5 alcoholic solution of ammonium acetate, until further heating results in no red coloring even with prolonged standing.

Titration Tests

To test the reliability of Emley's method for the present purpose, Lorenz selected a cement showing no reaction of free lime and ground it in a porcelain ball mill with 2, 5 and 8 per cent pure lime. Each of these mixtures was titrated three times; the results thus obtained are given in Table 1:

TABLE NO. 1

Reproducing Lime Titration According to Emley

	Cement with 2% Lime	Cement with 5% Lime	Cement with 8% Lime
First titration	2.15%	5.08%	8.10%
Second titration	1.95%	4.93%	7.92%
Third titration	1.90%	4.83%	7.96%
Average	2.00%	4.95%	7.99%

Three raw mixes differing greatly in their composition were used as material for the proposed measurements. Their analyses upon ignition are given below:

TABLE NO. 2

Raw Mix Analyses

	Raw Mix 1	Raw Mix 2	Raw Mix 3
Silica	19.35%	22.61%	22.23%
Alumina	8.32%	5.92%	3.44%
Iron oxide	7.21%	3.05%	3.22%
Lime	62.17%	66.38%	67.62%
Magnesia	2.66%	1.70%	2.57%
Sulphuric anhydride	0.29%	0.34%	0.92%
Hydraulic modulus	1.79	2.10	2.34
Silica modulus	1.26	2.52	3.44
Iron modulus	1.15	1.94	1.07

Mix 1 is a low-lime mix with low silica and high iron oxide content.

Mix 2 is a raw mix with average lime content, as used in the manufacture of ordinary portland cement.

Mix 3 is a high-lime mix approaching the soundness limit; it contains relatively little alumina, differing in that from mixes 1 and 2.

Calcination Tests

The calcination tests were carried out within the temperature range of 800 to 1500 deg. C. using intervals of 50 deg. C. in a Heraeus furnace with platinum coil in accordance with the process described by the author at the convention of the Association of German Portland Cement Manufacturers in Hanover[13], a detailed account of which can also be found in Tonindustrie-Zeitung .[14] All temperature measurements were made by means of the platinum-rhodium thermo-element.

The procedure consisted in adding enough water to the very finely ground raw mix to shape the mixture into rods similar to a short, thick pencil. These rods were dried, wound in platinum foil and placed into the heating tube of the furnace. The temperature was increased slowly at a rate constant in all tests and was kept for about 25 minutes at the desired limit. Upon completion of the calcination process, the current was switched off and the clinker removed upon a short cooling period in a still slightly glowing condition. In all tests, a current of air free from carbon dioxide was led through the furnace for the duration of the test, so that no carbon dioxide could be absorbed again during cooling.

Though, according to previous tests by Ullrich[15] no doubts could be entertained concerning the duplication and reliability of this calcination process, Lorenz nevertheless carried out some of the operations a number of times to establish by parallel tests that the individual tests stood in close agreement with each other. Only at temperatures in the vicinity of 900 deg. C. were differences found for identical test conditions, which were somewhat greater than the unavoidable errors. Apparently this is due to the fact that at this temperature the dissociation pressure of calcium carbonate reaches atmospheric pressure and the reaction takes place very rapidly with a strong evolution of carbon dioxide.

In one case differences were also found in measurements at a temperature of 1250 deg. C. This temperature range also indicates a very rapid reaction, as observed by Nacken[16] and also demonstrated throughout the present test series, so that the rate of the reaction tends to obscure the observation of a certain phase of calcination.

The results of Lorenz' determinations are given in Table 3; the per cent lime is figured upon ignition even for samples still containing carbon dioxide.

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[11] *Journ. of the Engl. Ind. Chem.*, 1909 I, p. 5. Report: Tremmel, *Zement*, 1927 p. 330.

[12] Trans., Am. Ceram. Soc., 1915, p. 720.

[13] *Zementprotokoll*, 1926, p. 46.

[14] *Tonindustrie-Zeitung*, 1929, p. 374.

[15] *Zement*, 1927, p. 167.

[16] *Zement*, 1920, p. 75; *Zement*, 1921. p. 246.

TABLE NO. 3

Free Lime Content of Calcination Samples

Temperature	Mix 1		Mix 2		Mix 3	
Deg. C.	White	Emley	White	Emley	White	Emley
800	pos.	6.93%	pos.	7.11%	pos.	7.22%
850	pos.	11.33%	pos.	13.00%	pos.	15.00%
900	pos.	14.47%	pos.	15.68%	pos.	18.32%
950	pos.	32.80%	pos.	36.80%	pos.	37.35%
1000	pos.	25.07%	pos.	30.64%	pos.	29.71%
1050	pos.	24.72%	pos.	29.50%	pos.	26.68%
1100	pos.	22.02%	pos.	25.65%	pos.	26.40%
1150	pos.	20.13%	pos.	25.11%	pos.	23.12%
1200	pos.	17.55%	pos.	17.81%	pos.	17.43%
1250	pos.	17.14%	pos.	12.58%	pos.	17.03%
1300	pos.	6.52%	pos.	6.18%	pos.	10.31%
1350	pos.	1.02%	pos.	0.27%	pos.	2.41%
1400	neg.	0%	neg.	0.05%	pos.	1.80%
1450	neg.	0%	neg.	0%	pos.	1.10%
1500	—	—	neg.	0%	neg.	0%

TABLE NO. 4

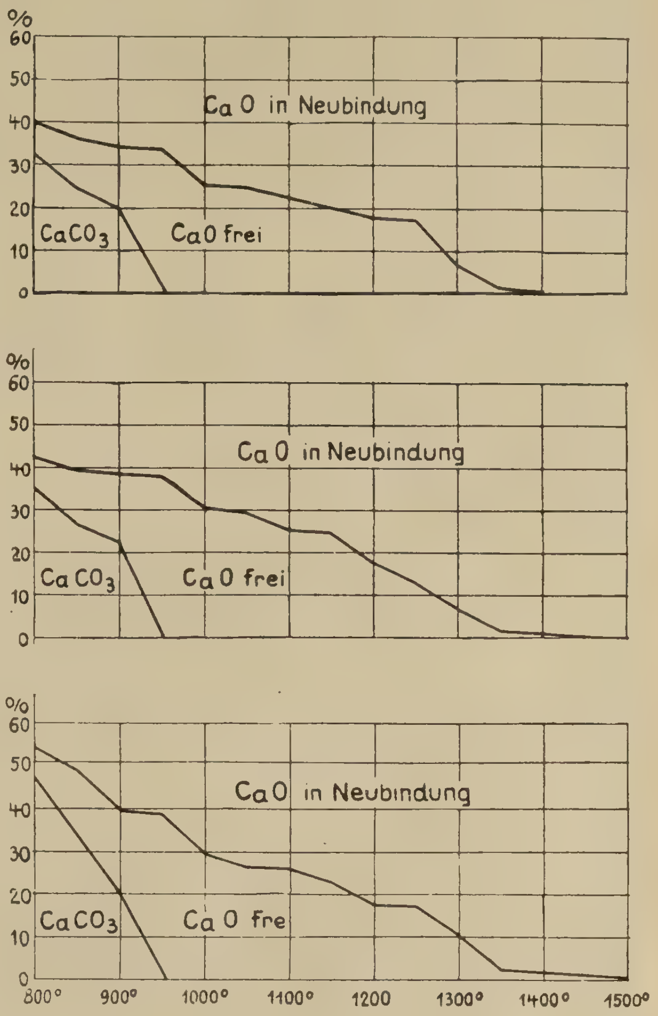
Carbon Dioxide and Lime of Carbon Dioxide in the Calcined Samples

Temperature, Deg. C.	Mix 1		Mix 2		Mix 3	
	CO_2(*) %	CaO(**) %	CO_2(*) %	CaO(**) %	CO_2(*) %	CaO(**) %
800	20.18	32.22	21.57	35.04	27.01	47.14
850	16.36	24.93	17.25	26.57	21.18	34.23
900	13.46	19.82	15.40	23.19	14.03	20.80
950	0.89	1.15	0.95	1.22	1.13	1.46
1000	0	—	0	—	0	—

(*) in the calcined sample.
(**) referring to ignited sample.

TABLE NO. 5

The Region of Free Lime (800 Deg. C. to 1500 Deg. C.) Raw Mixes 1 to 3



Aside from the free lime content, the carbon dioxide content was also determined for all samples and the results compiled in Table 4. Table 4 also gives quantities of lime, which upon completion of the test, remained combined with carbon dioxide, the quantities referring to ignited samples.

The graph of the reaction, established on the basis of these determinations for the three mixes, is reproduced in Table 5.

A study of the curves brings to light an extensive similarity in the reactions of the three mixes. This similarity is the more striking, as the mixes differ greatly in their composition, representing the entire range of mixes acceptable for the manufacture of portland cement. One may, therefore, conservatively state that the established reactions are typical for all portland cement mixes.

Carbon Dioxide Loss

Noteworthy is the fact that in all three mixes a considerable part of carbon dioxide, up to 50 per cent of the total carbon dioxide, is driven off at a temperature as low as 800 degrees C. This conforms to observations recorded by Monath, who established a considerable loss of carbon dioxide at even lower temperatures. This observation is not only of interest in connection with our present problem of the formation of clinker minerals, but sheds some light on the author's controversy with Hauenschild regarding the calcination processes of the automatic shaft kiln.[17] If carbon dioxide is driven off in such considerable quantities at such low temperatures, as established by Lorenz and Monath, the possibility of a reaction between the carbon dioxide of the mix and the fuel is greatly reduced.

Of even greater interest, however, is the fact that already at 800 degrees C. considerable quantities of lime have formed new compounds, and that at 950 degrees C., i.e., just above the dissociation temperature of calcium carbonate, almost half of the lime is already used up in reacting with the constituents of the clay: this shows that throughout the calcination process there is no phase during which the total quantity of available lime in the mix is free!

Although the curves illustrating the formation of lime in the three mixes cannot be said to give entirely parallel results, they nevertheless provide certain characteristic indications, which illustrate the progress of the reactions. This is true of the marked drop shown by all three curves between 950 and 1000 degrees C.; it indicates that a particularly rapid reaction of lime with the constituents of the clay sets in after the remainder of carbon dioxide is driven off from the raw mix. This phenomenon is in good agreement with the rule of mass action: at the moment, when the quantity of free lime begins to increase rapidly, this very increase in free lime accelerates the reaction of lime with the argillaceous compounds.

Reactions at 1250-1350 Deg. C.

A second marked drop is noticeable for all three mixes in the temperature range between 1250 and 1350 deg. C. This is the temperature range, in which, according to Nacken[18], the fusion of part of the mass results in a considerable contraction. The reaction takes place so rapidly, that at about 1350 deg. C. almost the entire quantity of free lime is used up; the remainder is slowly absorbed

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[17] *Zement*, 1928, p. 859, p. 1271, p. 1754; *Zement*, 1929, p. 64.

[18] *Zement*, 1920, p. 75.

TABLE NO. 6

Diagrammatic Computation of Lime Distribution

		Degrees														
CaO in	Maximum	800	850	900	950	1000	1050	1100	1150	1200	1250	1300	1350	1400	1450	1500
Test 1																
$CaCO_3$	62.17	32.22	24.93	19.82	1.15	—	—	—	—	—	—	—	—	—	—	—
Free New	62.17	6.93	11.33	14.47	32.80	25.07	24.72	22.02	20.13	17.55	17.14	6.52	1.02	—	—	—
Compounds	62.17	23.02	25.91	27.88	28.22	37.10	37.45	40.15	42.04	44.62	45.03	55.65	61.15	62.17	62.17	
$CaO.Al_2O_3$	4.56	4.56	4.56	4.56	4.56	4.56	4.56	4.56	2.31	—	—	—	—	—	—	—
$CaO.SiO_2$	17.99	17.52	14.63	12.66	12.32	3.44	3.09	0.39	—	—	—	—	—	—	—	—
$2CaO.SiO_2$	35.98	0.94	6.72	10.66	11.34	29.10	29.80	35.20	35.98	35.98	35.98	28.97	14.00	11.96	11.96	
$5CaO.3Al_3O_3$	7.60	—	—	—	—	—	—	—	3.75	7.60	7.60	7.60	—	—	—	
$2CaO.Fe_2O_3$	5.06	—	—	—	—	—	—	—	—	1.04	1.45	5.06	5.06	5.06	5.06	—
$3CaO.SiO_2$	53.97	—	—	—	—	—	—	—	—	—	—	21.03	32.97	36.03	36.03	—
$+2CaO.Al_2O_3$	9.12	—	—	—	—	—	—	—	—	—	—	—	9.12	9.12	9.12	—
Test 2																
$CaCO_3$	66.38	35.04	26.57	23.19	1.22	—	—	—	—	—	—	—	—	—	—	—
Free New	66.38	7.11	13.00	15.68	36.80	30.64	29.50	25.65	25.11	17.81	12.58	6.18	0.27	0.05	—	—
Compounds	66.38	24.23	26.81	27.51	28.36	35.74	36.88	40.73	41.27	48.57	53.80	60.20	66.11	66.33	66.38	66.38
$CaO.Al_2O_3$	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	3.25	—			—	—		—
$CaO.SiO_2$	21.02	20.98	18.48	17.78	16.93	9.55	8.41	4.56	4.02	—	—	—	—	—	—	—
$2CaO.SiO_2$	42.04	—	5.08	6.48	8.18	22.94	25.22	32.92	34.00	42.04	33.64	23.00	11.18	10.74	10.64	10.64
$5CaO.3Al_2O_3$	5.42	—	—	—	—	—	—	—	—	5.42	5.42	—	—	—	—	—
$2CaO.Fe_2O_3$	2.14	—	—	—	—	—	—	—	—	1.15	2.14	2.14	2.14	2.14	2.14	2.14
$3CaO.SiO_2$	63.06	—	—	—	—	—	—	—	—	—	12.60	28.56	46.29	46.95	47.10	47.10
$2CaO.Al_2O_3$	6.50	—	—	—	—	—	—	—	—	—	—	6.50	6.50	6.50	6.50	6.50
Test 3																
$CaCO_3$	67.62	47.14	34.23	20.80	1.46	—	—	—	—	—	—	—	—	—	—	—
Free New	67.62	7.22	15.00	18.32	37.35	29.71	26.68	26.40	23.12	17.43	17.03	10.31	2.41	1.80	1.10	—
Compounds	67.62	13.26	18.39	28.50	28.81	37.91	40.94	41.22	44.50	50.19	50.59	57.31	65.21	65.82	66.52	67.62
$CaO.Al_2O_3$	1.89	1.89	1.89	1.89	1.89	1.89	1.89	1.89	—	—	—	—	—	—	—	—
$CaO.SiO_2$	20.67	11.37	16.50	14.73	14.42	5.32	2.29	2.01	—	—	—	—	—	—	—	—
$2CaO.SiO_2$	41.34	—	—	11.88	12.50	30.70	36.76	37.32	41.34	34.46	33.66	21.48	5.68	4.66	3.06	0.86
$5CaO.3Al_2O_3$	3.15	—	—	—	—	—	—	—	3.15	3.15	3.15	—	—	—	—	
$2CaO.Fe_2O_3$	2.26	—	—	—	—	—	—	—	0.01	2.26	2.26	2.26	2.26	2.26	2.26	2.26
$3CaO.SiO_2$	62.01	—	—	—	—	—	—	—	—	10.32	11.52	29.79	53.49	55.32	57.42	60.72
$2CaO.Al_2O_3$	3.78	—	—	—	—	—	—	—	—	—	—	3.78	3.78	3.78	3.78	3.78

with increasing temperatures, so that at 1500 deg. C. even the mixes highest in lime show no evidence of free lime.

It is most interesting to make an attempt to picture the progress of the reactions by studying the curves of lime formation and to establish the sequence in which the different calcium-silicates, aluminates and ferrites are formed. Although an attempt of this kind would not be scientifically convincing without experimental data, it is, nevertheless, of value, as illustrated by Table 6.

In all three tests the three upper lines in Table 6 give values of "lime, carbon dioxide compound," "free lime" and "lime in new compounds" taken from Tables 3 and 4, computed on the basis of ignited samples, so that the sum of these three lime groups is equal to the lime content of the clinker—even in the case of samples still containing carbon dioxide. The following 7 lines show the distribution of the "new lime compounds" as silicates, aluminates and ferrites.

To make this computation, one enters in the first vertical column of Table 6 the maximum value of each individual compound in accordance with the analysis of the mix, i.e., the value which would be obtained were all of the alumina to be saturated with lime to monocalcium-aluminate or all of the silica to dicalcium-silicate.

To give to these computations a solid footing, certain assumptions had to be made concerning the sequence in which the different aluminates, silicates and ferrites are formed with progressively increasing temperatures. The following may be noted in this connection:

Although it has been said that Dyckerhoff's results obtained on pure compounds can not be directly applied to the processes of a commercial mix, it is nevertheless probable, that such compounds, as are formed *first* at high temperatures from pure compounds operated upon by Dyckerhoff, are also *first* formed at lower temperatures in the commercial mixes. Dyckerhoff has proved that of all compounds which may form from lime, silica and alumina, monocalcium-aluminate forms most easily and at relatively low temperature. Accordingly, the author has assumed that the first reaction between lime and the argillaceous substance causes the formation of monocalcium-aluminate.

Sequence of Reactions

Considerable doubt may be expressed as to which reaction is to be second. According to Dyckerhoff, monocalcium-aluminate readily becomes transformed to higher aluminates; yet as even at the lowest temperatures investigated by Lorenz the expenditure of lime could not possibly be accounted for by the formation of aluminates alone, but led to take into consideration the formation of calcium silicate, and as the temperature at which the first among the latter—the dicalcium-silicate—is formed, according to Dyckerhoff, is only 100 deg. C. higher than the temperature of the formation of monocalcium-aluminate, the author decided to place the formation of silicates as the second reaction. However, Dyckerhoff's theory was not strictly adhered to, as the author assumed that the available lime—possibly with dicalcium-silicate as an intermediate product—first forms monocalcium-aluminate and that only when the absorption of lime for this reaction has been completed, does dicalcium-silicate appear as such. This was based on the observation that within a certain temperature range, namely between 1000 deg. C. and 1300 deg. C., many of the samples showed deterioration, a phenomenon which was never observed on samples calcined below 1000 deg. C. or above 1300 deg. C. This observation stands in agreement with Ullrich's[19] test evidence, who obtained deterioration of otherwise stable clinker when calcining at temperatures of only 1250 deg. C. As there is no doubt that this deterioration is due to an excess of dicalcium-silicate, one must conclude that samples, calcined below 1000 deg. C. or above 1300 deg. C. do not contain considerable quantities of dicalcium-silicate. This can be true of samples calcined at temperatures below 1000 deg. C. only, when one assumes that lime and silica first react to form monocalcium-silicate. The fact, that with the sequence of reactions assumed by the author one encounters in all three mixes a sudden rise in the dicalcium-silicate content in the temperature range 950 deg. C. to 1000 deg. C., together with the appearance of the first deterioration phenomena at this temperature, seems to bear out these assumptions.

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[19] *Zement,* 1927, p. 182.

The question now arises as to how the lime continues to react with the constituents of the clay, after all of the silica is completely absorbed by the formation of dicalcium-silicate. The reactions which now set in may be the transformation of monocalcium-aluminate into pentacalcium-trialuminate and the formation of calcium ferrites. The author accorded first place to pentacalcium-trialuminate, because, according to Dyckerhoff, this compound forms readily, while, according to Nacken and Grünewald[20], the formation of calcium ferrites in larger quantities below their point of fusion is highly improbable and the yellow coloring of "underburned" material also disproves the presence of ferrites.

Reactions at 1200-1300 Deg. C.

In passing a calcination temperature of about 1200 deg. C., one leaves behind the zone of underburned clinker and deals with the sintering zone; the outward signs therefor are the change in coloring of the material from the "underburned" into that of the clinker, a strong contraction of the red hot mass and the appearance of an endothermic reaction, which, according to Nacken[21] and Dykerhoff[22] should be attributed to the formation of a fused mass. The nature of the chemical reactions, taking place in the temperature range between 1200 deg. C. and 1300 deg. C., has heretofore been unknown. The determination of the free lime, together with other observations, leads to the following deductions:

As soon as a certain quantity of calcium ferrite is formed it produces, together with the formerly obtained calcium-aluminates and calcium-silicates, an eutectic fused mass, whose formation makes possible the appearance of the actual clinker minerals, mostly alite and celite, which, probably throughout the fused mass, absorb the lime, first rapidly, then more slowly, from the aluminates and silicates formed in the solid state.

If this is the general sequence of reactions above 1200 deg. C., the question remains: what is the structure of the silicates, aluminates and ferrites, which form by absorbing lime from the primary compounds and produce the "clinker," i.e., the alite and celite (the main constituents of the clinker)?

It is very probable that the first ferrite to be formed is the monocalcium-ferrite; as the point of fusion of this compound, according to Nacken and Grünewald[23], lies around 1220 deg. C. to 1230 deg. C., its formation explains readily the appearance of a liquid phase between 1200 and 1300 deg. C. However, the author has not included monocalcium-ferrite in his computations, for it very soon passes into dicalcium-ferrite, leaving open the possibility that dicalcium-ferrite does not appear as such, but forms a double compound with a hypothetic dicalcium-aluminate—$4CaO . Al_2O_3Fe_2O_3$[24]. This compound forms, according to Hansen, Braunmiller and Bogue[25] a mixed series with dicalcium-ferrite, and, according to Jänecke [26], it constitutes the celite.

What Is Alite?

What should be our idea of alite? The author has recently stated that he considers alite a mixed series of Jäneckeit with tricalcium-silicate. As this statement was later contradicted by Jänecke[28], he has compiled in Table 7 the optic properties of alite and of those compounds, which, according to him and to Jänecke, constitute alite.

TABLE NO. 7

Optic Constants

	Average Refraction Exponent	Double Refraction	Optic Character	Angle of Optic Axis
Tricalcium-silicate[29]	1.715	0.005	negative	small
Jäneckeit[30]	1.705	0.004	negative	large
Alite[31]	1.716	very small	negative	30% to 40%
beta-dicalcium silicate[32]	1.726	0.01	positive	large

The practically perfect agreement of the optic properties of alite with those of tricalcium-silicate and Jäneckeit seem to bear out the author's contention, arrived at through chemical considerations, that alite is a mixed series of tricalcium-silicate and Jäneckeit, while the optically greatly different dicalcium-silicate can, in his opinion, be eliminated, aside from the fact that the lime content of ordinary and high-lime portland cements can in no way be reconciled with a dicalcium-alite.

Dyckerhoff maintains that neither of the two compounds—Jäneckeit or tricalcium-silicate—can occur in portland cement clinker, because they begin to form with sufficient rapidity only at temperatures far beyond the sintering temperature of portland cement clinker. Dyckerhoff's experiments dealt with mixes containing only silica, alumina and lime. As, contrary to Dyckerhoff's experience, the simple calcium-silicates and aluminates begin to form in a commercial mix at temperatures below 900 deg. C. at a not inconsiderable rate, one may assume that conditions of formation of the high-lime compounds such as tricalcium-silicate and Jäneckeit, are also more favorable in a commercial mix, than in one consisting of pure compounds. The formation of the fused mass between 1200 and 1300 deg. C. presupposes reactions, which lead to these two high-lime compounds. Both compounds are stable below 1600 deg. C.; they must form from their constituents, if the rate of the reaction is sufficiently high; this is reached, however, when the liquid phase sets in, during which the individual constituents become dissolved, react with one another and produce alite crystals as the product of the reaction. (Compare the chapter: "Sintering as physical-chemical problem" in Kühl and Knothe: *Chemistry of Cements*, p. 160 to 163.) The measurements made by Lorenz, which show that at about 1250 deg. C. the lime reacts with tremendous rapidity, this condition maintaining itself, depending upon the lime content of the mix, up to 1400 to 1500 deg. C., can, in the author's opinion, be explained in no other way but by his present, repeatedly developed theory!

As the alite, in accordance with the author's conception, is a mixed series of tricalcium-silicate and a hypothetic dicalcium-aluminate[33], he has included among the final products grouped in Table 6 these two compounds together with dicalcium-ferrite. It is of utmost interest, that in the high-lime mix 3, whose lime is completely absorbed only at a temperature of 1500 deg. C., the computations yield almost exactly the three components: tricalcium-silicate, dicalcium-aluminate and dicalcium-ferrite!

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[20] *Zement,* 1926, p. 561.
[21] *Zement,* 1920, p. 75.
[22] Dyckerhoff, *Dissertation,* p. 79, etc.
[23] *Zement,* 1926, p. 615.
[24] *Zementprotokoll,* 1928, p. 28.
[25] *Journ. Amer. Chem. Soc.* 50, 1928, p. 401.
[26] *Zementprotokoll,* 1928, p. 28.
[27] *Zement,* 1927, p. 1118.
[28] *Zement,* 1928, p. 1626.
[29] Rankin, *Zeitschr. f. anorg. Chem.* 92, 1915, p. 221.
[30] Dyckerhoff, *Dissert.,* p. 55.
[31] Guttmann and Gille, *Zement,* 1927, p. 922.
[32] Rankin, *Zeitschr. f. anorg.* Chem. 92, 1915, p. 220; *Dyckerhoff Dissertation,* p. 23.
[33] *Zement,* 1927, p. 1119.

Accordingly these three compounds form the final products of the lime reaction in high-lime portland cements; none of these, however, appears free, but contributes alternately to the formation of alite and celite as follows:

Alite as tricalcium-silicate + dicalcium-aluminate and
Celite as dicalcium-ferrite +dicalcium-aluminate.

This is expressed in Table 6 by joining these compounds for every mix with a brace, as the main clinker minerals.

The results of the present investigation may be summarized as follows:

1. In heating a cement mix, almost one half of the lime has formed new compounds with the constituents of the argillaceous ingredient by the time all carbon dioxide is driven off.
2. The formation of clinker minerals proceeds from the low-lime compounds progressively up to the compounds highest in lime.
3. The formation of dicalcium-silicate takes place predominantly in the temperature range 1000 to 1250 deg. C.
4. The appearance of the sintering melt at temperatures around 1250 deg. C. produces a very rapid reaction of lime, during which the intermediately formed calcium-silicates and aluminates become changed to the clinker minerals—alite and celite being the main constituents.
5. The lime quantities, which react with the constituents of the argillaceous ingredient between the temperatures 1250 to 1450 deg. C. are greater than they would be if dicalcium-silicate were the main constituent of portland cement clinker.
6. The progress of the lime reaction stands in complete agreement with the assumption, that alite is a mixed series of tricalcium-silicate and Jäneckeit or, numerically, a mixed series of tricalcium-silicate and dicalcium-aluminate.
7. Celite appears,—in conformance to Jänecke, as a mixed series of dicalcium-ferrite with a compound $4CaO.Al_2O_3.Fe_2O_3$ or numerically, as a mixed series of dicalcium-ferrite and dicalcium-aluminate.

Notable Safety Records Achieved by Quarries in National Safety Competition

The records achieved by a number of mines and quarries in operating over long periods of time without injuries to employees or with remarkably low accident rates, while participating in the National Safety Competition held during 1928 under the auspices of the United States Bureau of Mines, are characterized by Secretary Lamont of the Department of Commerce as a "definite and substantial contribution to safety in industry in the United States," in congratulatory letters addressed to the participating companies.

The 1928 contest marked the fourth holding of the National Safety Competition, which has as its purpose, through the medium of friendly rivalry, the reduction of the number of personal injuries in the mines and quarries of the United States. Competing companies were grouped into five classes, namely, anthracite mines, bituminous coal mines, metal mines, nonmetallic mineral mines, and quarries and open-pit mines. A bronze trophy, "Sentinels of Safety," the gift of "The Explosives Engineer" magazine, is awarded to the winning company in each group. The winner in each group was the mine or quarry whose record showed the smallest loss of time from accidents in proportion to the total amount of time worked by all employees.

The competition for the trophy was restricted to mines employing at least 50 men underground and to quarries and open-pit mines employing at least 25 men in the pit.

The best record among mines producing nonmetallic minerals other than coal was made by the Ironton limestone plant of the Alpha Portland Cement Company, Ironton, Ohio. At this plant 115,020 man-hours were worked without a single accident.

Alpha Record Best

In the nonmetallic mine group, honorable mention was given the Manheim mine of the Alpha Portland Cement Company, Manheim, W. Va., which also had no loss-time accidents; the Lower Gypsum mine of the United States Gypsum Company, Gypsum, Ohio, No. 1 mine of the United States Gypsum Company, Southard, Okla.; and the North Holston mine of the Beaver Products Company, Inc., North Holston, Va.

Among the open-pit mines and quarries, honorable mention was given the following, none of which sustained a lost-time accident: The Ormrod quarry of the Lehigh Portland Cement Co., Ormrod, Pa.; the Fordwick quarry of the Lehigh Portland Cement Company, Fordwick, Va.; the Cape Girardeau quarry of the Marquette Cement Manufacturing Company, Cape Girardeau, Mo.; and the New Castle quarry of the Lehigh Portland Cement Company, New Castle, Pa.; the Fogelsville quarry of the Lehigh Portland Cement Company, Fogelsville, Pa.; the Birdsboro quarry of the John T. Dyer Quarry Company, Birdsboro, Pa.; the Birmingham quarry of the Lehigh-Portland Cement Company, Tarrant City, Ala.; the Marcem quarry of the Pennsylvania-Dixie Cement Corporation, Gate City, Va.; the Superior quarry of the Superior Portland Cement Company, Concrete, Washington; the Vulcanite quarry of the Vulcanite Portland Cement Company, Phillipsburg, N. J.; the Speed quarry of the Louisville Cement Company, Speed, Indiana; the Greenport quarry of the Knickerbocker Portland Cement Company, Hudson, New York; the Petoskey quarry of the Petoskey Portland Cement Company, Petoskey, Michigan; the Dallas quarry of the Trinity Portland Cement Company, Dallas, Texas; the Bloomville quarry of the France Company, Bloomville, Ohio; the Catskill quarry of the North American Cement Corp., Catskill, New York; the Iola quarry of the Lehigh Portland Cement Company, Iola, Kansas; the Cowell quarry of the Cowell Portland Cement Company, Cowell, California; the Bonnerville quarry of the Lawrence Portland Cement Co., Northampton, Pa.; the Sandts Eddy quarry of the Lehigh Portland Cement Company, Easton, Pa.; the Birmingham quarry of the Alabama Portland Cement Company, Birmingham, Ala.; the Bath quarry of the Lehigh Portland Cement Company, Bath, Pa.; the Union Furnace quarry of the American Lime and Stone Company, Tyrone, Pa.; the Howes Cave quarry of the North American Cement Corp., Howes Cave, New York; the West Coplay quarry of the Lehigh Portland Cement Company, West Coplay, Pa.; the No. 4 quarry of the Pennsylvania-Dixie Cement Corp., Nazareth, Pa.; the Richmond open-pit mine of the Richmond Iron Company, Palmer, Michigan; the Toledo quarry of the Sandusky Cement Company, Toledo, Ohio; the Birmingham quarry of the Alpha Portland Cement Company, Birmingham, Ala.; the Mildred quarry of the Consolidated Cement Corp., Mildred, Kansas; the Spencer quarry of the Mid-West Crushed Stone Company, Spencer, Indiana; the Alpha quarry of the Alpha Portland Cement Company, Jefferson Barracks, Mo.; the Bellevue quarry of the Alpha Portland Cement Company, Easton, Pennsylvania.

MEN and MILLS

Notes from the Field

William W. Maclay Dies; Founder of Glens Falls Company

The death of William Walter Maclay, 83, former president of the Glens Falls Portland Cement Company, Glens Falls, N. Y., and one of its founders, occurred June 9th.

Mr. Maclay was a native of New York and was graduated from the United States naval academy in 1863. After the Civil war he was fleet captain of the Asiatic squadron. In 1868 he was appointed by the Japanese government to designate sites for lighthouses. He resigned from the navy in 1871 and became an engineer for the New York Department of Docks. While at the head of the Department of Docks, he was among the first engineers to require a rigid specification for the use of portland cement. Under his administration many of the most important New York docks were built and he won a high reputation in this field. He was president of the Glens Falls company from 1893 to 1905. During the early days of the Portland Cement Association he was an active member and on many of its leading committees. He afterward was consulting engineer with offices in New York.

Coors, United States Portland President, Dies in Fall

Adolph Coors, president of the United States Portland Cement Company, Denver, Colo., was killed when he fell from a hotel window at Virginia Beach, Virginia, on June 5th.

Mr. Coors was born in Brakel, Westphalia, Prussia, February 4, 1847. Upon coming to the United States in 1868, he organized two successful beverage companies and turned them over to his son in 1909, when he began devoting his attention to the cement industry alone.

Standard Flashlight Co. Inc. - N.Y.C.

Representatives sent to New York City to receive P. C. A. awards by cements plants who won 1928 *trophies by having no lost-time accidents are shown at the banquet given for them by J. B. Johns, on May 20th. Some of those present and the plants they represented were Manning Greer, H. C. Mason and Raymond Ford of the Marquette company plant at Cape Girardeau, Missouri; H. R. Shipley and J. C. Haines of the Oswego plant of the Oregon company; C. H. Denman and Henry Hall, Jr., of the Alpha plant at Bellevue, Michigan; W. J. Dermody and W. J. Schrutum of the Cowell plant at Cowell, Calif.; and John Dieterman and P. L. Rice of the Quincy, Mich., plant of the Wolverine company*

Cement Statistics for May

Production and Shipments for Both the Month and the Year to Date Lower—Stocks Show Increase—Total of Plants Now 161

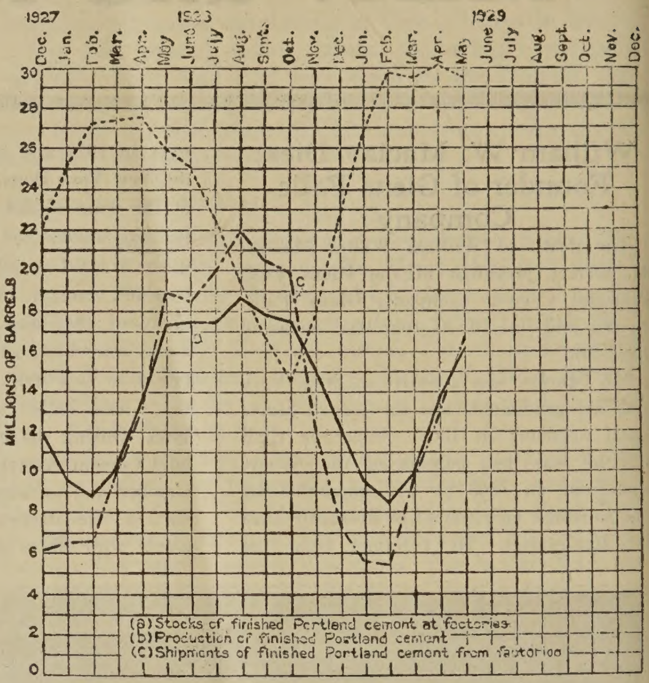
NOTE: IN ORDER THAT THE READER MAY KNOW THE TREND AT A GLANCE, THE HIGHER FIGURE, WHETHER FOR EITHER YEAR, UNDER ANY CLASSIFICATION, APPEARS IN SLIGHTLY HEAVIER TYPE.

Relation of Production to Capacity

(Figures represent per cent)

	May 1928	May 1929	April 1929	March 1929	Feb. 1929
The month	**86.6**	76.4	67.1	47.4	44.8
The 12 months ended	**73.9**	70.2	71.1	70.9	71.0

	1928	1929	Increase or Decrease, Per Cent
Production, May	**17,308,000**	16,151,000	—6.7
Shipments, May	**18,986,000**	16,706,000	—12
Stocks at end of May	25,984,000	**29,597,000**	13.9
Total production for year to date	**59,564,000**	58,273,000	—2.0
Total shipments for year to date	**55,532,000**	51,299,000	—8.2
No. of plants reporting	157	**161**	



Production, Shipments and Stocks of Finished Portland Cement, by Districts, in May, 1928 and 1929, and Stocks in April, 1929

District	Production—May 1928	Production—May 1929	Shipments—May 1928	Shipments—May 1929	Stocks at end of month 1928	Stocks at end of month 1929	Stocks at end of April, 1929*
Eastern Pa., N. J., and Md.	**3,823,000**	3,541,000	**4,200,000**	3,967,000	6,153,000	**6,355,000**	6,781,000
New York and Maine	**1,291,000**	1,137,000	**1,239,000**	1,184,000	1,899,000	**2,195,000**	**2,242,000**
Ohio, Western Pa., and W. Va.	**1,812,000**	1,595,000	**1,898,000**	1,660,000	3,482,000	**3,711,000**	3,777,000
Michigan	1,280,000	**1,387,000**	**1,507,000**	1,322,000	2,240,000	**2,724,000**	2,659,000
Wisconsin, Illinois, Indiana, and Ky.	**2,384,000**	2,065,000	**2,793,000**	2,356,000	3,011,000	**4,052,000**	4,343,000
Va., Tenn., Ala., Ga., Fla., and La.	**1,337,000**	1,276,000	**1,500,000**	1,301,000	1,888,000	**2,090,000**	2,114,000
Eastern Mo., Iowa, Minn., and S. Dak.	**1,766,000**	1,548,000	**2,143,000**	1,649,000	3,524,000	**4,261,000**	4,362,000
Western Mo., Nebr., Kans., and Okla.	**1,188,000**	1,117,000	**1,181,000**	1,007,000	**1,573,000**	1,527,000	1,416,000
Texas	531,000	**655,000**	**610,000**	563,000	389,000	**535,000**	443,000
Colorado, Montana, Utah, and Wyo.†	311,000	**363,000**	267,000	**334,000**	510,000	**521,000**	492,000
California	**1,175,000**	1,142,000	**1,235,000**	1,066,000	869,000	**997,000**	921,000
Oregon and Washington	**410,000**	325,000	**413,000**	297,000	446,000	**629,000**	601,000
	17,308,000	16,151,000	**18,986,000**	16,706,000	25,984,000	29,597,000	30,151,000

Production, Shipments and Stocks of Finished Portland Cement, by Months, in 1928 and 1929

Month	1928—Production	Production—1929	1928—Shipments	Shipments—1929	Stocks at end of month 1928	Stocks at end of month 1929
January	9,768,000	**9,881,000**	**6,541,000**	5,707,000	25,116,000	**26,797,000**
February	**8,797,000**	8,522,000	**6,563,000**	5,448,000	27,349,000	**29,870,000**
March	**10,223,000**	9,969,000	**10,135,000**	10,113,000	27,445,000	**29,724,000**
April	13,468,000	***13,750,000**	13,307,000	***13,325,000**	27,627,000	***30,151,000**
May	**17,308,000**	16,151,000	**18,986,000**	16,706,000	25,984,000	**29,597,000**
June	17,497,000	....	18,421,000	....	25,029,000	....
July	17,474,000	....	19,901,000	....	22,580,000	....
August	18,759,000	....	21,970,000	....	19,374,000	....
September	17,884,000	....	20,460,000	....	16,799,000	....
October	17,533,000	....	19,836,000	....	14,579,000	....
November	15,068,000	....	11,951,000	....	17,769,000	....
December	12,189,000	....	7,384,000	....	22,650,000	....
	175,968,000	....	175,455,000	....	....	....

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*Revised. †The inclusion of Wyoming begins with April, 1929.

New Standards of Steam Generation

750% BOILER RATING

Boiler ratings up to 750% have been carried for hours at a time on the Combustion Steam Generating units installed at Kips Bay Station of New York Steam Corporation. This is equivalent to over 450,000 pounds of steam per hour from single units.

1800-POUND PRESSURE

1800 pounds per square inch is the pressure specified for the Combustion Steam Generating units we are now building for Philip Carey Company, Lockland, Ohio. This installation will be the largest steam plant in the world operating at such a pressure.

800,000 POUNDS PER HOUR

800,000 pounds per hour is the guarantee on each of three units being installed for the New York Edison Company—660,000 pounds of steam per hour have been delivered by Combustion Steam Generating units installed at the Fordson plant of the Ford Motor Company.

The ability to offer Industry a service which is not available elsewhere — is responsible for these striking accomplishments. Complete fuel burning and steam generating units of coordinated design to meet exactly the individual plant need —comprising boiler, stoker or pulverized fuel equipment, furnace, superheater and air preheater — are sold under One Contract, One Responsibility and one set of guarantees. Our General Condensed Catalog briefly describes Combustion Engineering Corporation Equipment. May we send you a copy?

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With the Manufacturers

Alemite Publication

The June issue of *"Alemite Industrial Lubrication"* describes two instances in which manufacturers made not insignificant savings through the use of the Alemite lubricating system. A third brief article is entitled "Good Lubrication; A Mighty Factor in Present Conveyor Development."

The publication appears monthly and is prepared by the *Alemite Corporation,* Chicago.

Treatise on Lubrication

"Houghton on Industrial Plant Lubrication" is the first of a series of booklets on the subject to be prepared by the research staff of the *F. E. Houghton Company.*

This is a 56-page publication that deals quite comprehensively with the subject. Among the chapter headings are those concerning lubrication theory, objections to the use of mineral lubricating oils, lubrication of bearings, the fallacy of specifications, lubricating devices, etc.

Practical Starting Device

A 4-page folder prepared by the *Lincoln Electric Company,* Cleveland, Ohio, describes its Lincoln safety push button, for all electrical equipment. From this publication it may be seen that the "start" button, a vivid green, molded Bakelite, is inside the "stop" button, which is a Bakelite ring, bright red. The ring projects beyond the "start" button.

Hot Process Water Softener

Graver Corporation, East Chicago, Ind., has just issued a new catalog, 12 pages and cover, describing its hot water process water softener.

The catalog is well illustrated with views of installations and the component parts of the softener. Several tables are given showing the savings which have been made in various power plants by this softener.

A feature of this catalog is a flow sheet in colors. It is printed on an extension of the front cover so that the reader may have it before him when reading the descriptive matter.

Sprocket Book

Link-Belt Company of Chicago and Philadelphia has just issued a 38-page book, *No.* 1167, showing detailed specifications of the 15,000 sprocket wheels they now carry in stock.

At their plants in Chicago and Philadelphia, they maintain a stock of 15,000 sprocket wheels, made from over 1300 separate patterns, which need only to be bored and keyseated. Shipments can be made the same day the order is received, thus saving days or weeks formerly lost in waiting for sprockets to be made up on order, an announcement accompanying the publication states.

Electric Sifting Machine Models

Its electric sifting machines are illustrated and described briefly in an 8-page folder prepared by the Lowe Manufacturing Company, Detroit, Michigan.

The machine is described as operating suspended from a hook, bracket, beam or other support which will carry its weight of 125 lbs. The steel frame is narrow and without protruding parts. The base of the machine is 22 inches in diameter. There are no legs, tripods or other obstructions.

It is said to have a perfectly balanced gyratory motion of 1,725 gyrations per minute within a radius of ¼ in.

Armstrong Publication

"The Armstrong Driller," is a monthly publication gotten out by the *Armstrong Manufacturing Company,* Waterloo, Iowa. It has a blast hole and a water well section, and in them appear numerous short items of interest to portable drill users.

NOTES FROM THE FIELD

Wagner Branch

The Wagner Electric Corporation of St. Louis, Missouri, has moved its Buffalo service station and branch sales office to a new building at 1796 Main Street. The Buffalo office handles the entire Wagner line of motors, transformers, fans and Lockheed Hydraulic brakes, not only as a branch sales office, but also as a repair shop and service station.

The Wagner Electric Corporation announces the appointment, effective since May 1, of *L. G. Tandberg* as branch manager of its Los Angeles, Calif., sales office, at 1220 S. Hope Street.

Brown Branch Factory

The Los Angeles branch factory of the *Brown Instrument Company* is now located in the Westinghouse building, 420 S. San Pedro Street.

M. A. Long in Allentown

The M. A. Long Company, Long Building, Baltimore, Maryland, announces the opening of offices in the Commonwealth Building, Allentown, Pa. *E. C. Machin,* who, for sometime, has been in charge of building construction for the M. A. Long Company, will be resident engineer.

The M. A. Long Company also maintains offices in Washington and Chicago and a home office in Baltimore, Md.

General Electric Manager

Neil Currie, Jr., managing engineer of the motor department of the Pittsfield works of the General Electric Company for the past five years, has been named manager of the Philadelphia works of the company. Robert V. Good, section superintendent in the Schenectady works, has been named assistant to the manager at Philadelphia.

Mr. Currie, a graduate of the University of Minnesota entered the employ of the General Electric Company in 1908 through the purchase of the power apparatus department of the Western Electric Company. Mr. Good entered the employ of the General Electric Company in 1913. He has been a section superintendent at Schenectady since January 1, 1928.

Quigley Exhibit at Chemical Exposition

The Quigley Furnace Specialties Company, New York City, manufacturers of refractories, refractory guns, etc., made up its exhibit at the Twelfth Exposition of Chemical Industries at New York City May 6th to 11th, in two distinct divisions.

The first division pertained to *Hytempite* and other refractory products. An electric furnace was in operation, by means of which various properties of *Hytempite* were demonstrated under actual service conditions. A motion picture was in continuous operation, telling the story of *Hytempite* and its uses with reference to power plants and specific chemical applications.

A demonstration of the Quigley acid-proof cement represented actual service conditions in chemical industries and was designed to show the mechanical strength of the Q. A. P. cement in addition to its chemical resistance.

The other division of the exhibit was devoted exclusively to the Quigley "Triple-A" line of protective coatings.

A new series of Triple-A Protective Coatings were shown for the first time.